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THE DEVELOPMENT OF THE THEORY OF ELECTROLYTIC DISSOCIATION.*

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AT first sight nothing seems to be more evident than that everything has a beginning and an end, and that it is possible to divide everything. Nevertheless, the philosophers of antiquity, especially the Stoicist, concluded, on purely speculative grounds, that these opinions are not at all necessary. The wonderful development of science has reached the same conclusion as these philosophers, especially Empedocles and Democritus, who lived about 500 years B. C., and for whom the ancients had already a vivid admiration.

Empedocles professed that nothing is made of nothing, and that it is impossible to annihilate anything. All that happens in the world depends upon a change of form and upon the mixture or the separation of bodies. Fire, air, water and earth are the four elements of which everything is composed. An everlasting circulation is characteristic of nature.

The doctrine of Democritus still more nearly coincided with our modern views. In his opinion bodies are built up of indefinitely small indivisible particles, which he called atoms. These are distinguished by their form and magnitude, and also give different products by their different modes of aggregation.

This atomic theory was revived by Gassendi about 1650, and then accepted by Boyle and Newton. The theory received a greatly increased importance by the discovery by Dalton of the law of multiple proportions. For instance, the different combinations of nitrogen with

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oxygen contain, for each unit weight of nitrogen, 0.57, 1.14, 1.72, 2.29 or 2.86 unit weights of oxygen.* Between these combinations there is no intermediate proportion. This peculiarity is characteristic of chemistry in contradistinction to physics, where the more simple continuous and gradual transition from one state to another prevails. This difference between the two sister sciences has often caused controversies in the domain of physical chemistry. The occurrence of discontinuous changes and of multiple proportions has frequently been assumed, when a closer investigation has found nothing of the sort.

The law of multiple proportions is the one fundamental conception upon which modern chemistry is built up. Another is the law of Avogadro, which asserts that equal volumes of different gases under like conditions of temperature and pressure contain the same number of molecules. This conception, dating from the beginning of the nineteenth century, was at first strongly combated, and it was its great value in explaining the new discoveries in the rapidly growing domain of organic chemistry which led to its general acceptance in the middle of the past century, after Cannizzaro had argued strongly in its favor.

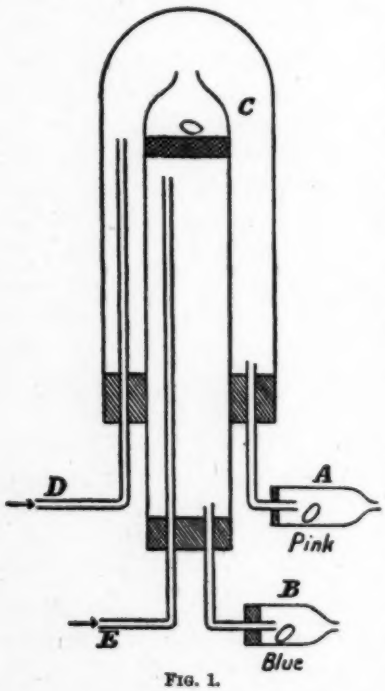

FIG. 1.

There were, however, some difficulties to be removed before Avogadro's law could be accepted. For instance, it was found that the molecular volume of sal-ammoniac, NH_4Cl, in the gaseous state was greater than might be expected from its chemical composition. This led to the supposition that the molecules of sal-ammoniac when in the gaseous state are partially decomposed into ammonia, NH_3, and hydrochloric acid, HCl. Indeed v. Pebal and v. Than succeeded in showing that this really happens. They used an apparatus that is shown in the annexed figure (Fig. 1). Two coaxial tubes are placed the one inside the other by means of a cork. The outer tube was closed at its upper end; the inner one was open and contained at C a diaphragm of asbestos and above that a piece of sal-ammoniac. The upper end was

*To explain this we suppose, in accordance with Dalton, that the molecules of the different combinations of nitrogen with oxygen contain two atoms of nitrogen and one, two, three, four or five atoms of oxygen.

heated by an air-bath, so that the piece of sal-ammoniac was volatilized. After this a current of hydrogen was led through both glass tubes D and E. Now ammonia diffuses more rapidly than hydrochloric acid; if, therefore, the vapor of sal-ammoniac is partially decomposed into ammonia and hydrochloric acid, we should expect that above the asbestos diaphragm there would be an excess of hydrochloric acid and beneath it an excess of ammonia. This v. Pebal showed to be the case. The hydrogen-current from D showed an acid reaction on a piece of litmus-paper in A, and that from E showed an alkaline reaction on a similar piece of litmus-paper placed in B. It was objected that the decomposition might possibly be caused by the asbestos of the diaphragm, or by the hydrogen. V. Than, therefore, made a diaphragm of sal-ammoniac, and substituted nitrogen for hydrogen, but the effect was the same.

These experiments were performed in the years 1862 and 1864. They were based on the doctrine of dissociation, which was at that time (1857) worked out by Ste. Claire-Deville, and developed by his pupils. From the most ancient times use was made of the fact that limestone at high temperatures gives off carbonic acid, and that quicklime remains. This and similar processes were studied by Ste. Claire-Deville. He found that the same law is valid for the pressure of carbonic acid over limestone and for the pressure of water vapor over liquid water at different temperatures. On these fundamental researches the theory of dissociation was based, a theory which has subsequently played an ever-increasing rôle in chemistry, and whereby a broad bridge was laid between physical and chemical doctrines.

At almost exactly the same time we find in the writings of Clausius on the conductivity of salt solutions the first traces of an idea that salts or other electrolytes may be partially dissociated in aqueous solutions. Buff had found that even the most minute electric force is sufficient to drive a current through a solution of a salt. Now after the scheme of Grotthuss, at that time generally accepted, the passage of the electric current through a solution is brought about in such manner that the conducting molecules, *e. g.*, of potassium chloride (KCl), are divided into their ions, which combine again with one another in the following manner: At first, as the current is closed, the electrode A becomes positive and the electrode B negative. All the conducting molecules KCl arrange themselves so that they turn their positive ions (K) to the negative electrode B, and their negative ions (Cl) to the positive electrode A. After this, one chlorine ion is given up at A and one potassium ion at B, and the other ions recombine, so that the K of the first molecule takes the Cl of the second molecule, and so on (Fig. 2). Then the molecules turn round under the influence of the electric force, so that we get the scheme 3 and a new decomposition

can take place. This represents the Grotthuss scheme, that supposes continuous decompositions and recombinations of the salt molecules.

As such exchanges of ions between the molecules take place even under the influence of the weakest electromotive forces, Clausius concluded that they must also take place if there is no electric force, *i. e.*, no current at all. In favor of his hypothesis he pointed to the fact that Williamson, as far back as 1852, in his epoch-making theory of the formation of ethers, assumed an analogous exchange of the constituents of the molecules. At this exchange of ions it might sometimes, though extremely rarely, happen that an ion becomes free in the solution for a short time; at least such a conception would be in good agreement with the mechanical theory of heat, as it was developed by Krönig, Maxwell, Clausius and others at that time.

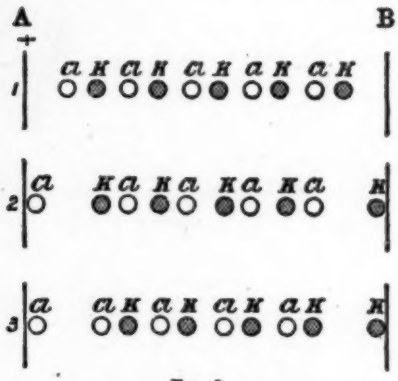

FIG. 2.

In the meantime, Bouty, and particularly Kohlrausch, worked out the methods of determining the electric conductivity of salt solutions. In 1884 I published a memoir on this subject. I had found that if one dilutes a solution—*e. g.*, of zinc sulphate—its conductivity per molecule, or what is called its molecular conductivity, increases not infinitely, but only to a certain limit. We may figure to ourselves an experiment performed in the following manner (Fig. 3): In a trough with parallel walls there are placed close to two opposite sides two plates of amalgamated zinc, $E E_1$. On the horizontal bottom of the vessel there is placed a layer of solution of zinc-sulphate that reaches the level 1. The conductivity may be k_1. After this has been measured we pour in so much water, that after stirring the solution the level reaches 2, which lies as much above 1 as this lies above the bottom. The conductivity is then found to be increased, and to have the value k_2. Increasing in the same manner the volume by addition of pure water until it is doubled, the level 4 is reached and the

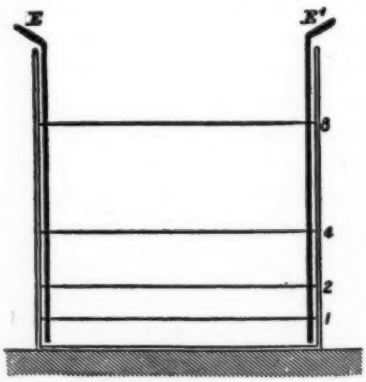

FIG. 3.

conductivity is found to be greater than in the previous case—say k_4. So we may proceed further and further; the conductivity increases, but at the end more slowly than at the beginning. We approach to a final value k_8. This is best seen in the next diagrams, which represent the newer determinations of Kohlrausch (Figs. 4, 5).

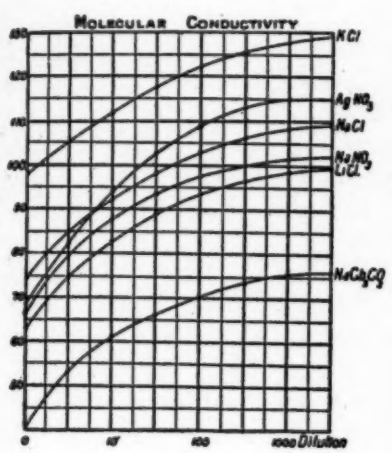

FIG. 4.

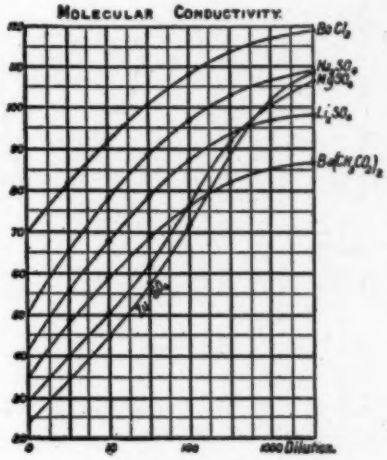

FIG. 5.

I explained this experiment in the following manner: The conductivity depends upon the velocity with which the ions (Zn and SO_4) of the molecules ($ZnSo_4$) are carried through the liquid by the electric force, *i. e.*, the potential difference between E and E_1. If this potential difference remains constant, the velocity depends only on the friction that the ions in their passage through the liquid exert on the surrounding molecules. As these, at higher dilutions, are only water molecules, it might be expected that the conductivity would remain constant and independent of the dilution if it be supposed that all molecules, $ZnSO_4$, take part in the electric transport. As experiment now teaches us that the molecular conductivity increases with the dilution, even if this is very high (1,000 or more molecules of water to one molecule of $ZnSO_4$), we are led to the hypothesis that not all, but only a part of, the $ZnSO_4$ molecules take part in the transport of electricity. This part increases with the dilution in the same proportion as the molecular conductivity k. The limiting value k_8 is approached at infinite dilution, and corresponds to the limit that all molecules conduct electricity. The conducting part of the molecules I called the active part. It may evidently be calculated as the quotient $k:k_8$.

If now this new conception were only applicable to the explanation of the phenomena of electric conductivity, its value had not been so

very great. But an inspection of the numbers of Kohlrausch and others for the conductivity of the acids and bases, compared with the measurements of Berthelot and Thomsen on their relative strength with regard to their chemical effect, showed me that the best conducting acids and bases are also the strongest. I was thereby led to suppose that the electrically active molecules are also chemically active. On the other hand, the electrically inactive molecules are also chemically inactive. In this connection I would mention the remarkable experiments of Gore, which were easily explained by the new point of view. Concentrated hydrochloric acid, free from water, has no action on oxides or carbonates. Now this hydrochloric acid is almost incapable of conducting the electric current, whereas its aqueous solutions conduct very well. The pure hydrochloric acid contains, therefore, no (or extremely few) active molecules, and this agrees very well with the experiments of Gore. In the same way we explain the fact that concentrated sulphuric acid may be preserved in vessels of iron plates without destroying them, whereas this is impossible with the diluted acid.

An unexpected conclusion may be deduced from this idea. As all electrolytes in extreme dilution are completely active, then the weak acids must increase in strength with the dilution, and approach to the strength of the strongest acids. This was soon afterwards shown by Ostwald to agree with experiments.

The Norwegian natural philosophers, Guldberg and Waage, had developed a theory according to which the strength of different acids might be measured as well by their power of displacing another acid in solutions as by their faculty to increase the velocity of chemical reactions. Therefore, we may conclude that the velocity of reaction, induced by an acid, would be proportional to the quantity of active molecules in it. I had only a few experiments by Berthelot to demonstrate this proposition, but in 1884, Ostwald published a great number of observations that showed this conclusion to be true.

The most far-reaching conclusion of the conception of active molecules was the explanation of the heat of neutralization. As this is much more easily understood by means of the theory of electrolytic dissociation, I anticipate this for a moment. According to this theory strong acids and bases, as well as salts, are at great dilution (nearly) completely dissociated in their ions, *e. g.*, HCl in $\dot{H} + \bar{Cl}$, NaOH in $\dot{Na} + \bar{O}H$ and NaCl in $\dot{Na} + \bar{Cl}$. But water is (nearly) not dissociated at all. Therefore the reaction of neutralization at mixing a strong acid, *e. g.*, HCl with a strong base, *e. g.*, NaOH, both in great dilution, may be represented by the following equation:

$$(\dot{H} + \bar{Cl}) + (\dot{Na} + \bar{O}H) = (\dot{Na} + \bar{Cl}) + HOH;$$

or,

$$\dot{H} + O\bar{H} = HOH.$$

The whole reaction is equivalent to the formation of water out of both its ions, $\dot{H}$ and $O\bar{H}$, and evidently independent of the nature of the strong acid and of the strong base. The heat of any reaction of this kind must, therefore, always be the same for equivalent quantities of any strong acids and bases. In reality it is found to be 13,600 cal. in all cases. This thermal equality was the most prominent feature that thermochemistry had discovered.

It was now asked in what respect the active state of the electrolytes differs from the inactive one. On this question I gave an answer in 1887. At that time van't Hoff had formulated his wide-reaching law that the molecules in a state of great dilution obey the laws that are valid for the gaseous state, if we only replace the gas-pressure by the osmotic pressure in liquids. As van't Hoff showed, the osmotic pressure of a dissolved body could much more easily be determined by help of a measurement of the freezing point of the solution than directly. Now both the direct measurements made by De Vries, as also the freezing points of electrolytic solutions, showed a much higher osmotic pressure than might be expected from the chemical formula. As, for instance, the solution of 1 gram-molecule of ethylic alcohol—$C_2H_5OH = 46$ grams—in one liter gives the freezing-point $-1.85°$ C., calculated by van't Hoff the solution of 1 gram-molecule of sodium chloride—$NaCl = 58.5$ grams—in one liter gives the freezing-point $-3.26 = -1.75 \times 1.85°$ C. This peculiarity may be explained in the same manner as the 'abnormal' density of gaseous sal-ammoniac, viz., by assuming a partial dissociation—to 75 per cent.—of the molecules of sodium chloride. For then the solution contains 0.25 gram-molecules of NaCl, 0.75 gram-molecules of Cl and 0.75 gram-molecules of Na; in all, 1.75 gram-molecules. Now we have seen before how we may calculate the number of active molecules in the same solution of sodium chloride, and we find by Kohlrausch's measurements precisely the number 0.75. From this I was led to suppose that the active molecules of the salts are divided into their ions. These are wholly free and behave just as other molecules in the solutions. In the same manner I calculated the degree of dissociation of all the electrolytes that were determined at that time—they were about eighty—and I found in general a very good agreement between the two methods of calculation. In a few instances the agreement was not so good; I therefore made new determinations for these bodies and some others. The new determinations were all in good conformity with the theoretical prevision.

The next figure (Fig. 6) shows the freezing-points of some solution of salts, and of non-conductors. As abscissa is used the molecular concentration of the bodies, as ordinates the molecular depression of

the freezing-point, divided by 1.85, that should be expected if no dissociation took place. As the figure shows, all the curves for the non-conductors—in this case cane-sugar, propyl-alcohol and phenol —converge towards unity with diminishing concentration. At higher concentrations there occur deviations from the simple law. As examples of binary electrolytes are chosen LiOH, NaCl and LiCl—their curves all converge towards the number 2. As ternary electrolytes are chosen K_2SO_4, Na_2SO_4, $MgCl_2$ and $SrCl_2$, they are decomposed into three ions, and their curves therefore all converge towards the number 3.

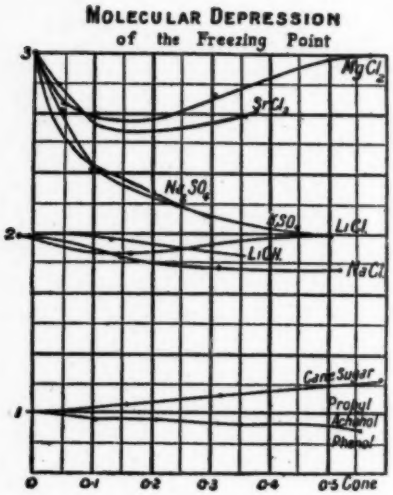

FIG. 6.

As I had taken a step that seemed most adventurous to chemists, there remained to investigate its chemical and physical consequences. The most general and wide-reaching of these is that the properties of a highly attenuated solution of an electrolyte ought to be additive, that is, composed of the properties of the different ions into which the electrolyte is decomposed. This was already known to be the case in many instances, and Valson had to this end tabulated his 'modules' by the addition of the one value for the negative to the other for the positive ion, we may calculate the properties of any electrolyte composed of the tabulated ions. In this way we may treat the specific weight (Valson), the molecular conductivity (law of Kohlrausch), the internal friction (Arrhenius), the capillarity (Valson), the compressibility (Röntgen and Schneider), the refractive index (Gladstone), the natural rotation of polarization (law of Oudemans), the magnetic rotation of polarization (Perkin and Jahn), the magnetization (Wiedemann), and all other properties of the electrolytes hitherto sufficiently studied.

The most important of these additive properties are those of which we make use in chemical analysis. As is well known, it is generally true that chlorides give a white precipitate with silver salts. It was said formerly that silver salts are reagents for chlorine. Now we say that silver ions are reagents for chlorine ions. This expression is better than the old one, for neither all silver salts, *e. g.*, potassium silver cyanide and many other compounds of silver, nor all chlorine compounds, *e. g.*, potassium chlorate and many organic chlorides, give this characteristic reaction. The experiment succeeds only with such

silver and chlorine compounds as are in a measurable degree decomposed into silver and chlorine ions. Ostwald has treated this question comprehensively, and in this way he has given a rational exposition of the general phenomena of analytical chemistry. To this fact belong, also, the poisonous effect of some salts; this effect may be considered as a special physiologically chemical reaction of the chemical compounds. On this point there are many valuable researches by Krönig and Paul, Clarke and others.

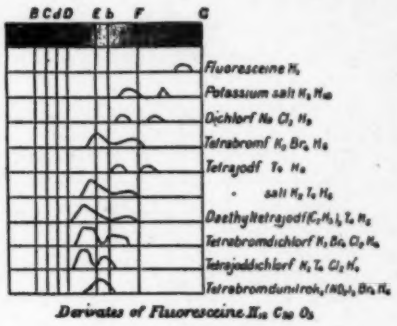
B C d D E b F G
Fluoresceine H_2
Potassium salt $H_1 K_1$
Dichlorf $Na\ Cl_2\ H_2$
Tetrabromf $K_2\ Br_4\ H_4$
Tetrajodf $I_4\ H_2$
salt $K_2\ I_4\ H_2$
Diethyltetrajodf $(C_2H_5)_2\ I_4\ H_2$
Tetrabromdichlorf $K_2\ Br_4\ Cl_2\ H_2$
Tetrajoddichlorf $K_2\ I_4\ Cl_2\ H_2$
Tetrabromdunitrok. $(NO_2)_2\ Br_4\ H_2$
Derivate of Fluoresceine $X_{20}\ C_{20}\ O_5$

FIG. 7.

A property that is of physical character, but is much used by the analytical chemist, is the color of the solutions. It has been subjected to a rigorous research by Ostwald. At first we will trace how a compound, *e. g.*, fluoresceine, $H_{12}C_{20}O_5$, behaves if one replaces its hydrogen atoms by other atoms, *e. g.*, metals, iodine, bromine or atomic groups (NO_2). The curves in the next figure (Fig. 7) indicate absorption-bands in the spectra of the corresponding compounds. A replacement of K_2 for H_2 in the fluoresceine itself alters the absorption-spectrum in a most sensible manner. This depends upon the property that the fluoresceine is dissociated to a slight extent, which is in striking con-

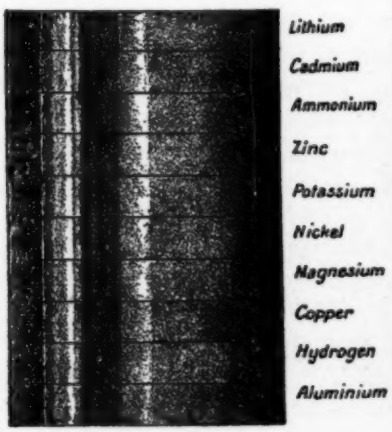

FIG. 8.

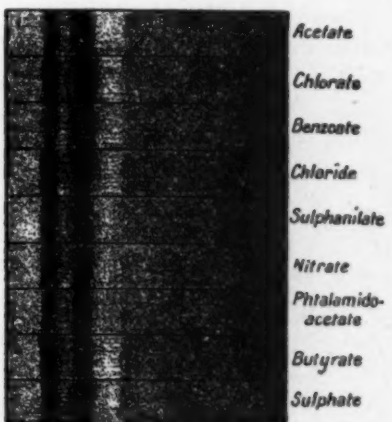

FIG. 9.

trast to the permanganic acid which will be discussed immediately. Instead of a single absorption-band in the blue in the first case, we find two absorption-bands in the blue-green and the green part of the spec-

trum for the second. A similar observation may be made for the tetraiodine-fluoresceine and its potassium salt. In general the figure shows that the spectrum is changed in a very conspicuous manner at the smallest chemical change of the molecule.

It might therefore be expected, after the old manner of view, that the replacement of hydrogen by a metal in permanganic acid, or of one acid rest by another in the salts of para-rosaniline, would wholly change the character of the spectra. This is not the case, as Ostwald has shown. The spectra are wholly unchanged, as Figs. 8 and 9 show. The spectra are all produced by the same substance, viz., the permanganate-ion, in the one, the para-rosaniline-ion, in the other case. Only in the case of the para-rosaniline salts we observe that the absorption is sensibly weaker in some cases than in others. The weakening depends upon the hydrolysis of the salts of the weak acids, *e. g.*, acetic and benzoic acids. This research of Ostwald shows in a most convincing manner the correctness of the views of the theory of electrolytic dissociation.

It has been objected to this theory, that according to it it might be possible by diffusion to separate both ions, *e. g.*, chlorine and sodium, from another in a solution of sodium chloride. In reality chlorine diffuses about 1.4 times more rapidly than sodium. But the ions carry their electric charges with them. Therefore if we place a solution of sodium chloride in a vessel and we pour a layer of pure water over it, it is true that in the first moments a little excess of chlorine enters the water. By this the water is charged negatively, and the solution under it positively, so that the sodium ions are driven out from the solution with a greater force than the chlorine ions. As soon as that force is 1.4 times greater than this, the chlorine ions travel just as slowly as the sodium ions. It is not difficult to calculate that this case happens as soon as the chlorine ion is contained in the water in an excess of about the billionth part of a milligram over the equivalent quantity of sodium. This extremely minute quantity we should in vain try to detect by chemical means. By electrical means it succeeds pretty well, as Nernst has demonstrated experimentally for his concentration elements. Therefore, the said objection is valid against the hypothesis of a common dissociation of the salts, but not against a dissociation into ions, that are charged with electricity, as Faraday's law demands. Probably this objection has hindered an earlier acceptance of a dissociated state of the electrolytes, to which, for instance, Valson and Bartoli inclined.

The gaseous laws that are valid for dilute solutions have made the calculation of the degree of dissociation possible in a great number of cases. The first application of that nature was made by Ostwald, who showed that the dissociation equilibrium between the ions and the non-

dissociated part of a weak acid obeys very nearly the gaseous laws. The same was afterwards demonstrated to be true for weak bases by Bredig. The strongly dissociated electrolytes, chiefly salts, exhibit even in dilute solutions (over 0.05 normal) anomalies, that are not yet wholly explained. Professor Jahn, of Berlin, is at work upon this most interesting question.

The equilibrium between a greater number of electrolytes has been investigated by myself, and found to be in good agreement with the theoretical previsions. This section includes the questions on the weakening of an acid by addition of its salts, and on the so-called avidity of the different acids, that is, the proportion in which two acids divide a base at partial neutralization. Calculation gives very nearly the numbers observed experimentally by Thomsen and Ostwald. For heterogeneous equilibria between electrolytes the theory is worked out by van't Hoff and Nernst, who have in this way elucidated the common method to precipitate salts used in analytical chemistry.

By help of the gaseous laws it is also possible to determine the heat evolved at the dissociation of a weak acid or base, and in this way I was able to calculate the heat of neutralization of acids and bases in a general manner. In an analogous way, Fanjung calculated the changes of volume at dissociation of a weak acid or base and at the neutralization of these bodies. All these calculations gave values very nearly agreeing with the observed ones.

An important rôle is played by the water, which may be regarded as a weak acid or base. By its electrolytical dissociation it causes the hydrolysis of salts of weak acids and bases. By observation of the hydrolysis, it was possible to calculate the electrolytic dissociation of water, and this quantity was soon after determined by electrical measurements by Kohlrausch and Heydweiller in perfect agreement with the previous calculations. For physiological chemistry this question is of the greatest importance, as is confirmed by the experimental results of Sjögvist and others. Also for the explanation of volcanic phenomena, the concurrence between water and silicic acid at different temperatures has found an application.

The catalytic phenomena in which acids and bases are the chief agents, have been investigated by many observers, and it has been found that the catalytic action depends on the quantity of free hydrogen or hydroxyl ions that are present in the solution. To this review, that makes no pretension to be complete, may also be added the wide-reaching researches of van't Hoff, Ostwald, and especially Nernst, on the electromotive forces produced by the ions. By these investigations we have now acquired an explanation of the old problem of the manner in which electromotive forces in hydro-electric combinations are excited.

I have now traced the manner in which the idea of electrolytic

dissociation grew out of our old conception of atoms and molecules. Sometimes we hear the objection that this idea may not be true, but only a good working hypothesis. This objection, however, is in reality no objection at all, for we can never be certain that we have found the ultimate truth. The conception of molecules and atoms is sometimes refuted on philosophical grounds, but till he has got a better and more convenient representation of chemical phenomena, the chemist will, no doubt, continue to use the atomic theory without scruple. Exactly the same is the case for the electrolytic dissociation theory.

This theory has shown us that in the chemical world the most important rôle is played by atoms or complexes of atoms, that are charged with electricity. The common tendency of scientific investigation seems to give an even more preponderating position to electricity, the mightiest agent of nature. This development is now proceeding very rapidly. Already we see not only how the theory of electrons of J. J. Thomson, in which matter is reduced to a very insignificant part, is developing, but also how efforts are made with good success to explain matter as only a manifestation of electrodynamic forces (Kaufmann-Abraham).

To these modern developments the work of British men of science has contributed in the most effective manner. The bold previsions of Sir William Crookes seem to be rapidly acquiring a concrete form, to the great benefit of scientific evolution.

CONSERVATION OF HUMAN ENERGY, PRESERVATION OF BEAUTY.

By Dr. J. MADISON TAYLOR,
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THE paramount importance of retaining human beauty is a fact requiring so little demonstration as to simulate a fundamental truth. All historical records bear witness to this verity. Popular interest seems extraordinarily awakened in this direction of late years, and in particular the daily press teems with observations on the subject. Much of it, however, is misleading and liable to bring a really vital subject into contempt. This paper is the expression of a desire on the part of the writer to place the matter on the plane which it deserves. Whatever merit the following observations contain, at least they seem to the writer worth offering, being the result of practical labors in the right direction, and from which satisfactory results are known to have come to a few faithful followers. It will be admitted, too, that the theme eminently merits the attention of all; for if so much of beauty as has been vouchsafed to each can be retained beyond the period when that elusive quality ordinarily subsides, it is a quest justifying some effort.

It is not to be expected that delicacy of coloring in skin or hair, the special prerogative of youth, shall be preserved beyond early middle life. Arduous attempts to modify the inevitable changes which normally appear in these tissues, are of doubtful efficiency, even questionable propriety. It is true that through the exercise of care and temperance much may be done to postpone serious marring of the skin texture and quality, but coloring must change. Nor is it advisable to resent this. Beauty of youth is *sui generis;* so is that of maturity; and it is the part of wisdom for each one to adopt measures which shall bring about a fitness in appearance consistent with the actual age reached. It is, however, entirely possible to postpone indefinitely those changes in bulk and contour, in form, in poise, in gait and carriage, which arise chiefly from neglect of suitable precautions; for these defects need not obtrude till toward the end of a long and busy life. History, both ancient and modern, is replete with examples of persons who, appreciating these facts, have enjoyed well-deserved reputations for great charm of appearance, especially grace and symmetry, well beyond the fifth and sixth decades. We have in our time conspicuous instances of

men, and women also, who are of the age of grandparents, and yet are altogether attractive and beautiful.

The time was, and recent too, when most men on reaching the age of thirty-five or forty adopted a quiet costume and demeanor of stability and left off regarding themselves as sharing in any part of their resigned youth. The same voluntary transition was even more noticeable among women, especially the married ones. When the duties of life lay most largely about the domestic hearth the duties and privileges of parenthood were accepted and enjoyed with no, or little, thought of acquiring the pose of perpetual adolescence. A change has been wrought, for good or otherwise, and it becomes a matter of common remark that we have no middle-aged folk any more. People are either young or they are old. As for inevitable conditions, little need be said; they must be accepted and made the most of. It has been decided, however, that now-a-days we shall stay young as long is possible, hence it behooves those of us who are the conservators of health to teach our clients the best measures by which youthfulness may be conserved and cellular structures held in equipoise.

There is much to be said in favor of such a decision. Assuredly, a man is to be commended for desiring to see the wife of his bosom long retain those qualities which first swayed his judgment and determined his choice. The Almighty put into the heart of his people certain instinctive impulses, the following of which brings about mating. Beauty of face and form, varying as it inevitably must, in accordance with racial or local standards, is the deciding factor in espousals. No doubt we can be made to believe that soul appeals to soul in these momentous yet sudden decisions, which we all made, and our children will make yet after us. But comeliness is and should be the final arbitrament. Happily there are many types and adequate varieties.

"There is a beauty of the flesh, and there is likewise a glory of the spirit which illumines the flesh. In the most pleasing of human countenances these good gifts are blended in just, though varying, degrees." It is possible for one or the other extreme to prevail and each be satisfactory to the beholder. This again depends upon the caliber of the spectator; his or her mood and training. If the spirit works so powerfully here as some would have us believe, it follows that the wisest men and women should make their choice less by reason of propinquity than is demonstrated by history and experience. The instinctive impulses are primarily wholesome, and make for good, but, unless modified by judgment, tend inevitably toward selfish indulgences which mar the most beautiful human complex.

It would seem pertinent, however, to make some effort at understanding what the elements of that beauty are, which is so well worth the preserving. While this concept might be attained, it is by no

means certain that it could be reduced to words, or formulated with exactness. Standards of beauty exist consonant with views not fixed and immutable, varying with many factors, racial, national or local, and fluctuating with fashion and accident or precedent. There is great dearth of agreement among the arbiters, and those who have been most industrious in promulgating their views differ so widely that we are, in the main, reduced to accept individual opinions, and our own always seems the most rational or acceptable. However, allowing for the great diversity which exists between the standards prevailing in Darkest Africa, the Valley of the Amazon, the South Sea Islands and New York or Paris, certain rules hold good, with rare exceptions.

As to the features of the face we need offer few comments; this would become too wide a discussion. The largest measure of beauty capable of preservation lies in the contours and poses of the body. It will be useful to indicate briefly what standards should be held in mind toward which to strive. Ease of movement and gracefulness of carriage are at the basis of what is called style. The other elements are dignity and restraint, betraying reserve power; always normality and accuracy of coordination and suitability of action consistent with the demands of environment and circumstances. The term 'well set up' is often used and may be taken to evidence such balance in the tension of the opposing symmetrical muscles as shall preserve a nicety of equipoise with economy in motor energizing, so that each movement follows with accurate and unconscious, though restrained, force. Full relaxation is the starting point of all effort; the conservator of action.

One so endowed will be found, as a rule, to exhibit a straight back, the spinal column practically vertical, viewed from the rear, and when looked at from the side, the normal curves at neck and waist line will be distinctly less marked than common. The pelvis will be nearly on a level and not markedly tilted forward and down in front, so obvious in fat people or those of lax fiber. The shoulders are held well down and directly in the mid-line (viewed from the side), but with the ribs more nearly at right angles to the spinal column than is seen in those who exhibit exaggerated nuchal and lumbar curves. The head is well balanced upon a round straight neck, which is slightly inclined forward, and there will be almost no curve in the upper thoracic vertebræ. A vertical line would fall from the back of the head to the middle of the shoulders. These features originally possessed or acquired, as they can be, make possible a slimness of waist fully compatible with health. If this attitude is maintained the depth of the chest consists of an elevated position of the ribs, giving them their largest diameters, anteroposteriorly and laterally.

The level pelvis and relatively straight lumbar spine compel a wholesome action of the abdominal parietes, by which full support of

the loosely attached abdominal organs is maintained and the waist kept small, preventing unsightly thickening of the tissues in this region.

A small waist is only beautiful if the lateral line drops into the hip gradually and passes out over the hip bone in a steady but not sudden curve. If the curve dips in abruptly and springs over the hip bone at an acute angle, giving a waspish appearance to the waist, it argues for flabby tissues about the abdomen, sides and back. Such slimness evinces a lack of early development, weak digestive and other vital organs, and tendency to speedy shapelessness. It is a difficult matter to regain vigor in such tissues. The upper chest should be full and fairly broad, and if the collar bones show, as is often seen in both plump and thin people, some fault exists in the tension of the muscles and tissues of the thorax, shoulders and back and the lungs have not attained full apical expansion. This being overcome, the clavicles should not appear at all, because the ribs will then be held normally and nearly at a right angle to the spinal column. There should be ample space in the lower rib areas, indicating lung room and vigor of diaphragm. The arms should hang easily, without tension, and fall a little in advance of the middle of the hip bone. Any stiffness in the arms or shoulders or elbows makes for awkwardness. In walking, the pelvis should be kept practically level, the tissues between the shoulder blades and along the backbone should hold the chest erect and keep the breastbone well up in front. Then the thighs will be able to move easily with no undue weight falling on the heel. If a person strikes the heel heavily on the ground in walking, these precautionary points are neglected and grace can not follow. The normal sway of the arms in walking is slightly toward the mid line in front; any tendency for them to fall toward the back, or worse than all, behind the back, is a hideous fault, and unless the back is grossly curved, causes the body to pitch forward clumsily on the heels. A good rule is to keep the base of the neck well back against the collar and the lobes of the ears as far as possible above the tips of the shoulders.

It is obvious that to retain beauty one of the first considerations must be to habitually exercise economy of all the natural forces; avoiding so much of those wastefulnesses of wear and tear as is possible in the ordinary exigencies of daily life. It may be answered to this truism that it is scarcely feasible, or indeed desirable, to order one's life on such a plane of artificiality or selfishness, as shall make for the shirking of communal labors and responsibilities. This need not be claimed as the result of the practise of these normal economics. It should be the duty of all teachers, parental or professional, to inculcate in the young a philosophic attitude toward annoyances, disappointments, even calamities, for of these every mother's child of us

must meet his full share. Indeed, to escape all such vexations would by no means tend to elevate the soul or ennoble the mind, but rather evolve an insipid character, bereft of the essential attributes which make for that perfect quality of spirit, the possession of which can alone impart a desirable beauty to the countenance. "Fortitude, steadfastness and the makings of character come not of rainbow dawns and quiet evenings and the facile attainments of small desires;" and the defences against ugliness which wealth and position are supposed to afford (by those who have them not) are at best disappointing. A little with contentment is admittedly the ground of great gain. Again, labors and the meeting of difficulties hurt neither body nor spirit unless they so affect both that the habit of worry inculcates a mental bias toward peevishness or despair. Nothing mars the human image of God so swiftly and inevitably as fretfulness and complainings. So true is this, as an item of common knowledge, that the countenances of chronic invalids and real sufferers are known often to be, and remain through long painful years, beautiful and satisfying. Again it frequently happens that persons thus successful in enjoying for themselves, and presenting to their friends, a fund of pleasure and satisfaction, did not originally possess the key to this boon, but acquired their charm by wisely schooling their minds until the blessing came. Much more could be said to demonstrate that features, mental or physical, which one may greatly desire can often be gained in spite of original shortcomings and the buffets of fate. So much then for the higher possibilities which lie open to those who earnestly desire to do, or be, or get something better than their circumstances seem to warrant.

In securing economy of the vital forces, admittedly so desirable, the chief factor is to conserve the ebb and flow of innervation. This is the key to the situation. The cellular waste may be estimated as direct and indirect. The direct waste is simpler and less hurtful, as the needless energy expended by the muscles of an arm exerted to raise a weight in such a fashion that twice the power is put forth required to perform a task. Indirect extravagance of energy is a far too common habit (for habit it becomes whatever the original impulse) by which tension is maintained in more muscles than are concerned in the performance of an act, whereby a prodigality of nervous force is expended. Again between the performance of all muscular acts, there should be periods of complete relaxation of tension, by which alone prompt repair is secured. Back of and controlling all this is the emotional balance whereby the nervous energy is made to act to an undue prolongation, or to a squandering of the cellular consumption. Thus it is that two persons, or the same person on different occasions, set forth to do a bit of work requiring precisely the same effort. One

will by economy accomplish the full result and not be fatigued—the other works excessively and is wearied. The first is the better for the doing—the second feels exhausted at the end. The nervous system is in continual education from the cradle to the tomb. It is better to maintain constant and accurate though economic functionation. Overuse, or worse, disuse, results in dimming the lamp of life, and the consequence is a marring of the elements of beauty. Complete relaxation or poise is the starting point of all effort.

The most important ground for possible safeguarding and prolonging of human comeliness is by means of securing and maintaining full elasticity of all the tissues. Old age may be described from the standpoint of physiology, as the period of hardening of the structures; it is one of development, not necessarily of decay. This is both inevitable, a normal change, and also there are many threatening exigencies standing ever ready to carry it over to the realm of disease.* The prevention, as well as the cure, lies in the deliberate, accurate employment of normal movements. If the activities have been habitually of an objectionable sort, monotonous in character as from labors limited in scope or from choice, or inadequate in variety and character, the tissues acquire stiffness sooner than they should. If the individual has never acquired full symmetric development of muscles, as is true of the large majority, these changes will appear earlier, and become more conspicuous. Again, full muscular balance and competence is conditional upon a certain degree of intelligent direction and impulse. Sensations exist for the specific purpose of inciting us to action, either immediate or remote. If they fail to initiate the proper actions their failure is absolute. Brain exercise of all kinds is accompanied with motor elements; no force is lost. If the associative fibers in the brain are inadequately developed by use and training there must be a deficiency both in motor and in sensory areas. If the early sensory promptings are insufficient in kind and variety there must result inferior human machines. Action of all kinds, mental and muscular, conditioning both efficiency and grace, can only exist in proportion to the power and variety of the stimuli and responsiveness of the centers. Action is the result of memory images, the outcome of sensory promptings. It is efficient if encouraged and is not if these stimuli are neglected or suppressed.

Old age is too often looked upon by those who have reached it as an evil fate to be resented or bewailed. Without combating this view from the standpoint of philosophy, let us reflect rather upon the many instances of beautiful old age which it has been our privilege to know. Is not this picture of well spent years familiar? "She was a wonderful creature with bloom and color, endowed with an intensity,

* See THE POPULAR SCIENCE MONTHLY, March, 1904, article by author—subtitle 'Physiology of Decadence.'

a mobile charm, which breathed of forces long maturing and almost perfect. She regarded life from a standpoint of abundant humor but never to the detriment of highest ideals."

In man old age is admittedly a crowning of honors won and esteem earned. It remains for him to secure or lose this reward. Fate rules, it may be, but his rulings can be potently modified by him who wills and acts. To woman advancing years come as the sealing of a well, if she has eyes only for the surface of things, and is blind to the warmth and life of the under-currents whose power is oftener overlooked than weakened. It is far more a question of what manner of woman she was, or has become, than of age or appearance as judged by the critical. If she feels tempted to grow slovenly in the niceties of pose and expression or in her dress, let her check this as a sin: for sin it is, and an offence against God and his good gifts. Women of three, or even four, score years have reigned queens in society. Many prefer a smaller kingdom, content with modest spheres of influence; but let them exercise care as to the line and direction of ambitions and be sure of their fitness to fill the niche of their choice. Once chosen it is a simple equation between vigilance and tact, rather than between the inherent worth of their charms and the fusing points of their subjects.

If hints are needed how to attain exalted posts of honor or ornament, here are some modest ones. Interest in the doings of her fellows, exhibited judiciously; a capacity to listen with an air of real interest to the fountains of speech artfully loosed; a clarity of mind on matters of the day, private and public; a gentle dignity coupled with what we may call graciousness; these will carry a woman miles beyond another in the esteem of her fellows who, making light of these gifts, yet possesses much intellect, endless accomplishments and striking physical beauty. If a woman tends to become giddy or frivolous, especially in her later years, so soon as she realizes this ruinous bias let her quell it or seek a cloister without delay. If she acquires, moreover, a manner of condescension or patronage, she may attune her mind to move thereafter much alone.

It may be said by any one who has read so far, that generalities may incite to reflection, but specific directions are required to demonstrate how each one may attain that grace and elasticity which is the very basis of original, and much more so of retained, comeliness. Beauty may be given to a few, and fewer are able to hold it without effort beyond the ordinary period when it tends to fade. It is a plain physiologic fact that comeliness may be enormously enhanced, but it is necessary that intelligent effort be exerted to secure a continuance of this endowment. Again, a person may possess many, or enough, of the elements of beauty and yet so abuse these gifts by omitting to

exercise a self-respecting care that their physical attractiveness may never exert the influence which in duty bound it should. The possessor of beauty is, to quote the immortal Bunthorne, 'a trustee' with responsibilities definite and grave. To ignore these, to suffer them to fall into neglect, is a misdemeanor in young or old.

Beauty may be marred by factors both psychic and physical. Physical deteriorations are of wide variety, some preventable and others inevitable. Where disease steps in it should be philosophically endured, but only up to a certain point, because even here apparent destiny need not be accepted as final. Disease is sin, hence preventable in great measure and remediable in a large degree. The greatest peril is from listlessness, self-indulgence or indifference, or, worst of all, from unwise meddlesome advice.

Can beauty then be increased by effort? Yes, and to a conspicuous degree. Can good looks be retained as age advances to, or beyond, middle life? Decidedly much can be done, even for those who in earlier years had little or none, and be made to remain with one till death. This is practicable, too, by the expenditure of only a moderate degree of time and pertinacity. The *sine qua non,* however, is a sincere and zealous desire for results. No tepid willingness will suffice. The arrogant woman or man who condescendingly submits to such measures as shall be outlined here, but fails to supplement them by earnest cooperation, should use time and strength otherwise. There must be an investment of hours and energy, and above all of intelligence. Along with this must be assumed a submission to some slight bodily discomforts, at least at first; by and by the means employed become a positive and unfailing source of pleasure and comfort and there soon arises an increased and sustained capacity for enjoyment and usefulness.

It is possible only to speak in general terms in so brief an article and to enunciate merely fundamental principles. These can be amplified in proportion to the wisdom and vigilance of each. They are best first taught in outline by experts and later can be systematized and pursued alone. The line of action should involve a clear notion of bodily hygiene, food, rest, sleep, bathings, care of the skin, teeth, hair, outings, clothing, etc. Every one may think he or she knows enough about each and all of these points, but will find that there is yet much to be learned if the subject is approached with an open mind. A great deal that is currently accepted on physical fitness is wofully archaic, and yet ample knowledge exists for those who search diligently. Recognized authorities are too often palpably ignorant in some important quarter, and all the dicta of teachers should be critically weighed in the light of advancing physiology, and only their tenets accepted if genuinely sound.

The one central thought which I wish to emphasize is the paramount principle that beauty of form depends upon accurate adjustments of the skeletal structures along with the fullest possible elasticity of the tissues. Perfect equipoise assumes elasticity of muscles and complete mobility of ligaments and tendons consonant with their functions along with capacity for fullest relaxation. Further, as age advances and disease or mal-use exerts its deforming effects, undue pressure is placed upon vital structures such as blood vessels and nerves, and innervation and circulation are interfered with, less or more, until as middle life passes and plasticity subsides, various noble tissues are impaired and vital organs suffer functional limitations. For instance, the eye, the ear, the brain thus fail to maintain perfect nutrition, and acuity of vision, hearing and cerebration lessen steadily, unless the tissues of the neck are kept free from rigidities. The fact is obvious enough and capable of easy demonstration, that the more elastic person enjoys fuller organic competence than one whose tissues are dense or rigid.

Density is bad enough, for reasons cited, but it is worse if deformity is added. For thereby is not only the caliber of blood vessels and nerve fibers, tendon sheaths, structures of the thorax, etc., compressed, but the lungs, because of thoracic incompetence, become incapable of exerting their full duty in oxygenation, and the power of the great oxygenating grounds, the muscles, begins to wane. Ugliness inevitably follows, not confined to shapelessness and warping, but color suffers, not only of skin or hair, but congestions or lividities are shown upon eyes, lips and nose. Nothing so centralizes the esthetic effect as the condition of the eyes; if these are clear and bright much else is overlooked.

Again, inadequate oxygenation and lymphatic stasis are correlated. Mere bulkiness is not displeasing to the eye, and many fat people are exceedingly handsome, often graceful, and exhibit most agreeable lines and color. A far more uncomely appearance is produced by the unhealthy thickening of tissues, only too common, occurring about the waist line from lymphatic stasis in those otherwise not overnourished. This water-logged condition often indicates grave departures from health and is capable of much amelioration, oftentimes it can be entirely removed, and always with advantage to health as well as to appearance. Free exercises will not accomplish so much as elasticizing movements judiciously increased, full passive stretchings, readjustments and full accurate breathing. It is true that violent and prolonged gymnastic performances will do a good deal, but these are often not feasible, or are distasteful, and the intelligent employment of personally directed exact movements can always be most safely relied on. The one essential principle is accuracy, with increased forcefulness to the limit of tension, with intervening periods of complete relaxation.

If medical men knew more of the subject of the physiology of bodily esthetics, they would be preeminently the ones to give counsel. Physicians know, however, almost nothing of the science of physical economics and leave this whole most important department of improving physical efficiency to those who teach for hire. They occasionally recommend loosely that those under their care shall take physical culture, but they would be sorely puzzled to differentiate between good and bad instruction. This is almost as true for those who have been, in their day, more or less athletic themselves as for the contentedly sedentary. Hence when the assertion is made that it is among the most exalted duties of the physician to give specific advice in this line, many will brand the statement as absurd. Nevertheless, the physician is the one who by his scientific training should be best able to point out the faults of posture, the defective quality of tissues, why they are not fulfilling their functions properly, and precisely how they can be made to do so. The consequence is, now that physical culture is so popular, all manner of blatant ignorant folk are posing as instructors and specialists in improving the body, and much harm is often thus caused, sometimes unrecognized till long after. Yet so much good is often thus effected that people are disposed to welcome these ignoramuses as prophets of wisdom and abide by their advice rather than seek counsel of legitimate educated conservators of health. Nevertheless, the fad of physical culture is distinctly to be welcomed with all its present limitations and even its perils. It will leave a valuable impress on the period. In due time the medical profession will give it their attention, and competent expert advice can be expected from them.

Let me make a few suggestions, from the standpoint of a medical man long and practically interested in this subject, to those who desire to preserve their looks and by so doing their health; for the terms are in effect interchangeable. As has been said, this essay is directed chiefly to the conservation of elasticity, poise, movements and graceful contours. Much can be accomplished by free movements, plays, games, both indoor and outdoor, but among those who are brilliant exponents of all these pastimes will be found many very awkward in action and faulty in poise, who are sufficiently well formed and of skilful and accurate coordination. Some such persons, even of advanced years, have been trained by the writer to move and appear to vastly greater advantage by pointing out the key-note defect and showing just how this may be overcome. For illustration, take the position of the torso in one who stoops or droops. This may be only a bad habit of holding the head, yet if this alone is corrected without having the attention called to the correct position of the neck on the chest, or the balance of the shoulder blades and the tonicity of the erector spinæ muscles, etc.,

erectness of the head may appear merely stilted and arrogant, and little is gained.

To tell a person of slouching figure, stiffened by advancing age, warped by ligaments in faulty poise, to stand up straight and throw back the shoulders, etc., will accomplish little or no good. It is necessary to point out specific faults of structure, correct weakened or contractured tissues, to teach just what precise movements can strengthen the one and elasticize the other. Where contractures are noted (and they are always present, less or more) the parts must be sedulously overstretched. This will be somewhat painful, but only at first. For daily or bi-weekly systematic teaching a skilled masseur or physical trainer can and will take more time and give more constant attention than the physician could afford, but it is impossible to expect these trainers to estimate individual needs scientifically or carefully, especially as progress must be made, if at all, in a consistent direction. Movements for acquiring elasticity should by no means be confined to the limbs; the largest gains are to be secured in the deeper structures of the thorax, shoulders, back and loins. Here the expert eye of an anatomist is needed. Even more so in those most important structures of all, the abdominal organs. Large knowledge and experience are required to permit or encourage accurate adjustments of these parts. All movements, active or passive, of an educational character, should be made with the utmost accuracy of direction, or they fail in some measure of utility. Furthermore, a fundamental principle is to make each movement with increasing forcefulness, till at the end of the act the fullest tension is secured. In this way alone can strength, elasticity and full coordinative power be attained.

Time also is a potent factor, along with persistence. There is always more or less rigidity to be overcome in the tissues, often unrecognized minor deformities and limitations which mar both attitude and freedom of action. It has taken the writer years to rid himself of some such rigidities, and most folk are similarly circumstanced. Especially is this true of the thorax, which, even in late middle life or advanced age, is yet capable of large emendation and increased efficiency well worth the effort. Much indeed can be effected here by right breathing accurately taught; full forcible inspiration followed by complete expiratory expulsion, always with careful rhythm and judicious variations in rate.

It must be remembered that voluntary movements of the muscles are always valuable and often necessary to maintain the powers of oxygenation by which cellular interchanges are carried on, so that nutrition may progress, the organs kept to their normal activity and restful sleep obtained. It is possible that the nutritive balance may continue more or less well in some people under certain circumstances and for

a long time with very little bodily activity, but the omission is a grave peril.

This capacity for passive circulatory equipoise varies widely, but can not be relied upon to carry any one far unless supplemented by a moderate amount of voluntary action. Some folk claim to obtain enough physical stimulus from mental activity, especially when energetically directed, to suffice for their apparent needs. By intense cerebral energizing undoubtedly metabolism is stimulated, more food demanded and waste disposed of, than when thought is lowered to musings. Some can do with active conversations and laughing. Also music acts wholesomely in the same way. Hence it is compatible with fair health to live a sedentary life, but only if the circumstances of life be, and remain, uniform and wholesome, and the bodily functions so symmetrically carried on that no great strains come and no nutritive nor degenerative disorders arise.

For all, young and old, it is important, in order that full mental and physical health be maintained, that systematized bodily activities shall be practised with some regularity. From this conclusion there is no escape save by self-deception. Assuming then that we have a perfectly normal body upon which to reckon influences for good or evil, we will proceed to analyze the effect of voluntary movement. If a person is entirely oblivious to his own consciousness, that is, entirely free from hyperconsciousness, movements will be made easily and in accordance with instinctive impulses. If the mechanism be perfect or nearly so, the movements made in the ordinary activities of daily life will be entirely natural and consistent with the special structure and abilities of the individual. Provided also that the opportunities for these movements be natural, and sufficiently varied, and if there be adequate stimulus to move, and continue to move, throughout the ordinary exigencies of a working day, and further, if nothing interferes with the normality of these movements, the result should be perfect action and development.

It rarely happens, however, that such a status is maintained. Several influences creep in more or less forcefully to interfere with the symmetry and naturalness of bodily movements. The first factors which should be reckoned with in altering the symmetry of the body are minor inherent defects of development in the skeletal structures by which a tendency is early established for the stronger side to overwork the weaker one. This will be better understood in the brief anatomical description which will be given later. The second thing is dress. In proportion as dress exercises undue pressure on one or another part, it is capable of modifying structure and altering growth. What these influences are we shall mention in detail later. Next such influences as environment, habits, fashion and energy or indolence

largely deviate shape and carriage. Lack of variety in movements due to repetition of laborious acts exerts a modifying influence, usually for harm. It is not the effects of fatigue on the entire organism, but rather continued repetitions of movements by which the one part most exercised adjusts itself along the lines of least resistance to do its work most comfortably, which produces a warping of the unused complemental part. And finally the most potent agency of all in producing awkwardness and tension is exaggerated hyperconsciousness.

By far the largest proportion of those peculiarities of gait and carriage which are noticed in almost every one, although they may begin primarily in some structural peculiarity and are modified by dress and occupation, nevertheless are exaggerated enormously by this over-consciousness which affects somewhat every one. It will be plain to those who will reflect for a moment how differently they will walk and act in the privacy of their own rooms or among their families and friends from that which they will present if called upon to exhibit themselves in some public position. Let any one remember the time when first called to walk the floor of a crowded room while for a moment the cynosure of a large number of watchful and presumably critical eyes. Here the hyperconsciousness may become so marked as to produce in some a mental agony, which will be vividly reflected as a rule in suppressed writhings or contortions. This effect upon the body may not be outwardly shown to any marked extent, but an irregularity of tension is produced in the various parts which distinctly mars their natural ease of action or attitude.

Many of the deformities which come upon women are not recognized by them as such, and yet to the critical eye they are departures from the normal lines of development, and the results of habitually faulty attitudes, not present in youth. They need not have been acquired except through the artificial restraints of custom and a desire to conform to conventional poses. Such are the stiff or awkward and certain hyperconscious positions assumed by a lady when arrayed for display in public; witness the indrawn elbows, the contractured hands, either clutching a portion of her dress or a pocketbook, or both. It is apparently against the canons of taste to permit any freedom of motion, either at elbow or at shoulder. The gait becomes a constrained strut, because it is practically impossible to allow the thighs to move with naturalness and ease. In mobile adolescents, this is not so offensive to the observer, but as age creeps on and youthful elasticity is gratuitously sacrificed, as well as rapidly lost from senile changes added to disuse, the picture presented of an elderly woman parading the thoroughfares is too often a repulsive one. On the other hand, if she ceases striving to make a good appearance and abandons herself to indolent attitudes, to droop and slouch, the spectacle is even worse. This unfor-

tunate state need not arise, if, as a girl, the woman becomes acutely alive to the value of retaining grace (which is entirely practicable), provided nature has endowed her with fairly symmetrical bodily proportions along with accurate instincts as to attitudes (all too rare a gift). More to be welcomed, because thoroughly acquirable by any one, is a wholesome guidance of the growing body and wise instruction in the right standards of breathing, standing and moving. There is an eminently practical value in avoiding this state of acquired awkwardness, which has a direct and important bearing upon health and longevity. It may be permitted to again direct attention to the derangements which follow upon constrained attitudes, habitually maintained, in compressing the chest, hence the lungs, heart and the great organs, and particularly because of the less obvious, but equal, peril from constriction of important arteries, veins and nerve trunks. It is difficult to convey to the lay mind the gravity of posture deformities, practically the same condition as occupation and costume deformities; the differences being merely of causation and degree. It is quite comprehensible how grave an effect is wrought upon the morphology of the organs, for example, in a miner who assumes various unnatural attitudes demanded by his work, in nooks and crannies of rock. Here he lies or stoops for hours at a stretch, digging laboriously, and in time becomes grossly misshapen. Still he is in constant action and the elasticity of the tissues is not lost so early as in many other occupations where constrained positions are maintained with little change and only such movement demanded as is limited in scope, monotonous and exhausting by endless repetitions. The song of the shirt has brought some phases of the subject to the public attention. Let any one visit large manufactories and he will acquire a vivid object lesson. It will be perhaps more clear to call attention to the deformities of neglect. Unless a child has enjoyed the fullest opportunities for spontaneous activities, numberless small abnormalities will arise and become emphasized. Observe any group of school children critically and there will be readily noted posture deformities in most of them well established and liable to become fixed and exaggerated in later life.

A strong argument for employing a wide variety of bodily movements can be drawn from the fact that man being the only upright mammal, many of his organs assume and are maintained in positions and relationships foreign to their original adaptation. Ages and generations of characteristics acquired in the upright attitude have given him large control over these organs and their supporting tissues have developed admirable adjustments adequate to all ordinary needs and under ordinary requirements. Among the requirements for healthy organic structures is always exercise or use whereby alone function is conserved and organs maintained in normal position and condition.

These exercises should be along the normal functional lines, not out of them, but keeping in view the fullest range of customary movements, many of which become impaired and almost lost from lack of accurate use even in young persons. First of all, bear in mind that nine tenths of ordinary movements of the arms are flexions, hence it is necessary, in order that one may become symmetrically developed to practise forceful, accurate extensions till complete extensor competence is attained. The movements of the legs are mostly extensions, hence in them flexions must be cultivated systematically.

In the motor areas of the brain there are probably two sets of cells coexisting alongside, one for flexions, and one for extensions. In the arm centers those for flexions are in constant use, hence well developed, and the extensor cells suffer degenerative change. In the center for the legs the reverse obtains. The neck and structures about the shoulder blades in man are little used in the ordinary demands of life, where few movements are called for, and hence are seldom brought into full action. These readily become rigid from disuse and fail to maintain symmetry. Yet in this region lie some of the most important subsidiary nerve centers. The effects of these rigidities by exerting pressure on nerves and blood vessels impair nervous mechanisms, and hence the nutrition of the organs of special sense in the head suffer. As these are removed dimness of vision grows less, hearing more acute, discomforts or pains in the head cease, and youthful capacities and *bienfaisance* are in great measure restored.

Unless these tissues are kept mobile, especially at the age when free activities are gradually abandoned, this region loses beauty rapidly and nowhere is the evidence of age more conspicuous.

Diet, already alluded to, exerts a most influential bearing on health, and hence comeliness. It is enough to offer here a brief summary of the guiding principles of dietetics which will suffice for all ordinary exigencies. A word must be said about the care of the teeth upon which often the whole proposition depends. Teeth receive good attention by nearly all civilized people to-day, yet we physicians are often amazed at the instances of neglect which fall under our observation. Many of these dental defects prove to be the chief factor in obscure conditions of deplorable ill health, even among people of wealth and refinement. This is especially true of disorders of the gums.

In order to maintain digestive competence, from intake to output, it makes far less difference what food is eaten, than the manner of taking, and the amounts consumed. In the choice of foods, a good rule for most people is to make a selection from those articles which are ordinarily accessible and eat with contentment and thankfulness, being guided by a purely natural appetite. Artificial environment and faulty upbringing tend to impair the sanity of taste and appetite, and

ill health may, and does, vitiate both. Instinctive desires are always present, if not obscured, and can be trusted.

Varying conditions of the body, fatigue, emotion, exercise, indolence and the like, make conditions which influence choice at a meal, both of articles and amounts, which demand obedience. Not one mouthful more than nature craves should be swallowed. Certain rules obtain as to times of eating, and sequences of dishes, to which we must conform, but it is entirely possible to do so with judicious selections and rejections. Age makes much difference in all this. In middle life, and later, a small amount of food will suffice for all requirements. The greatest safeguard lies in cultivating the tastes of earlier and simpler years, bearing in mind that in the period of full development we eat to maintain life with little need to develop structures, unless acute or prolonged illness has caused unusual destruction demanding repair. Forcing the appetite may be at times needful, but it is always a peril unless advised by a physician. When in doubt, go hungry for a day. Thus will the whole array of disorders of metabolism, gout, diabetes and the like be limited. Careful preparation of food is desirable, but superior cooking is secondary to many other considerations. Simplicity in preparation comes next to cleanliness, and soundness is of course to be assumed as necessary, particularly in articles of the more perishable sort. It is well to avoid adventitious aids to flavoring such as tricks of combination and overmuch condiments. These irritate the organs of perception and ultimately impair both digestive vigor and the sense of taste. By far the most important rule to observe is that all food shall be most deliberately masticated and each mouthful involuntarily swallowed before any more be taken into the mouth. This holds good for fluid foods, especially for milk.

Finally, one word as to fluids with meals. Digestion is a process of solution by hydration and about a glassful of water is needed at each meal. Fluids taken before or after meals are ordinarily permissible. If any is taken during the meal at least no partly masticated food should be in the mouth to be 'washed down.' If so it has not been sufficiently comminuted or insalivated, and does not enter the stomach in perfect condition for assimilation.

One word as to the effects of the corset. The use of the corset we may be compelled to accept as a feminine necessity, but if so it argues for the wearer a loss of normal tissue vigor much to be deplored. As an auxiliary to modern dress, which fashion dictates shall be close-fitting around the waist, we have little to say, but as a support to the abdominal structures, a remark is justified. There is no essential demand for artificial aid to sustain the abdominal organs, but if such need is felt to exist, it is, and can only be, due to consciousness of a structural defect. This has been demonstrated repeatedly in many

women, old and young, by educating the muscles of the waist till they were able to comfortably meet all demands, actual and artificial. If corsets are claimed to be required on esthetic grounds, the reply is, that among well-constructed women, whose tissues are normal and who have acquired and retained normal attitudes, no improvement can be made by empirically adapted mechanisms. This is proved by the universal admission of the fact that a young girl of good figure does not require corsets. A bust support or special waist can be used if demanded, but this should not be a confining, unyielding cuirass. Then it follows that those who insist that elaborate molding contrivances are imperative by the making of this demand, tacitly admit that they have become already deformed. The question must then be faced whether this deformity is the mark of fate, or is due to individual culpability. If the former be true, let them accept if they must the compulsion of machine-made figures to conform to the dictates of fashion. If acquired by faulty attitudes, lethargy or epicurism, or all three, let them set about recovering as from a disease. This is entirely possible, and only otherwise if the person is irresolute or ill-taught.

Again, there are long backs and short backs, with various degrees of space between the ribs and the pelvic bones. A woman with a long back and plenty of room between the thorax and the pelvis, can wear a corset with less danger, because the greatest hurt is from interference with the action of the lower parts of the lungs. It is a grievous sin against health to restrict the chief oxygen laboratory. For this oxygen interchange full muscular action alone will not suffice; free lung room is essential. A woman with a short back, but plenty of room between ribs and hips, may wear a low or narrow corset with small danger. When there is little soft tissue between these parts the ribs are readily prevented from full play. Then not only lung action is impaired, but liver, kidneys and stomach are all compressed and made to relax from their supporting tissues, and tend to fall down confusedly toward the bottom of the abdomen. Hence arises the long train of ills growing commoner daily in all corset-wearing countries: movable kidneys, livers, dropped stomachs and intestines, and above all displaced organs of generation. The chief damage from the corset is the circular compressing action exerted upon the blood vessels of the waist, whereby passive congestions are induced in all tissues, and the great organs are forced downward, aggravating the weakness of the already mechanically frail normal supports. The straight front corset is only a little less bad, since it presses inward constantly, and all continued pressure exerts paralyzing effects on vaso-motor nerves and muscles. The least harm is done by that form of corset which has as part of its action, a low-placed firm semi-elastic belt so adjusted as to hold up the contents of the abdomen from a level with the outer hip prominence, and thus prevents the downward pressure of the rigid waist-encircling garment.

ART IN INDUSTRY.

By FRANK T. CARLTON,
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The Significance of the Arts and Crafts Movement.

DURING the last century the productive powers of man were multiplied many times by the utilization of the energy of coal and water through the agency of steam and electricity. As a result the human race has been lifted from a condition of struggle for the necessities of life to a higher plane of material comfort. With the increase of material wealth has been ushered in the new spirit of democracy. Leisure, culture, education, art and work are now conceived to be the birthright of all. Universal education and culture has heretofore been impossible because of the meager productivity of the unaided man. The arts and crafts movement of to-day is democratic. It proclaims to the world that beauty, skill and education are for all; and that the common thing should be made beautiful, and the beautiful, universal. If the machine enables us to produce the necessities of life for all, it is, nevertheless, the skilled human hand which must adorn and beautify these products. The hand must find its province where the machine can not go. In its proper sphere, the machine may make beautiful things, and may even excel the hand; it is not the use of the machine, but the abuse of machine production, which should be deprecated; without the machine much of our present material comfort would be impossible.

Art is a form of industry, and industry properly applied always brings forth a work of art. The mechanic, fashioning the accurate and splendid tool, produces a work of art; the man, forming with infinite care the lenses of the great Lick telescope, brings into being another work of art. The automatic screw machine and the steam engine are as certainly works of art as the painting or the sculpture of the great masters of the Renaissance. There is and can be no real art considered entirely apart and distinct from industry and the industrial life of the people. As Emerson has said: "Beauty must come back to the useful arts and the distinction between the final and the useful arts be forgotten." Art is a way of doing things and resides in the common as well as in the uncommon, at home as well as abroad, in the present as well as in the past.

The old craftsmen were artists. They wrought with infinite care as much for the satisfaction of doing good and true work as for the money value of the product. The products of the craftsman's skill

were few, and only the ruling classes were privileged to possess them. The laboring masses were busily engaged in obtaining the bare necessities of life; no thought of comfort, art or education entered into their lives. The craftsman did unite art and industry; but the modern conception of democracy did not exist. On the other hand, the modern workman is only a link in a great industrial chain. He repeats, in a monotonous routine, certain simple movements; no realizing sense of the true social value or significance of the work which he performs ever comes to him. Long hours and routine work crush the individuality and ambition out of him.

The specialized worker necessarily has narrow views of life; his ability to enjoy is limited. The opportunity and privileges of both working and leisure hours are only partially utilized. It has been said that for a man of twenty, pleasure is business; of thirty, business is business; and of forty, business is pleasure. It might further be maintained that there is little pleasure outside of business for the ordinary man of forty or fifty. Business, the grind of daily life, has engrossed the entire energies of the man. Enjoyment in life means enjoyment of leisure and of work. The unskilled laborer, I fear, enjoys neither—why? His work is monotonous and wearing, the surroundings of home and workshop are not inspiring, and he has received no training which will aid him in finding and utilizing the few opportunities for rational enjoyment which come to him.

The present arts and crafts movement is a protest against and a reaction from the minute division of labor now employed in manufacture, and the stripping of the artistic features from industry. Articles are made to sell more particularly than to serve a useful and important service. Profit, not service, is now the watchword of industry. Art in the crafts would emphasize service. The arts and crafts movement aims to give dignity to the worker, and to teach that all should be workers. The man of leisure is a drone and a parasite. Each individual has some particular work for which he is best adapted; and society needs his services. Only when all are workers and each striving to do his best work does society approach an ideal condition.

The arts and crafts movement needs educated producers and consumers. The task is a double one; the workers must be trained to produce good work, and the taste of all consumers must be educated so that they will demand good articles. Shorter hours and the right use of leisure will give an impetus to the demand for better qualities of goods; and thus variety and handicraftsmanship will to some extent replace interchangeability and machine production. All civilized men demand the necessities of life—food, clothing and shelter—of a character not greatly dissimilar; these common requirements lend themselves readily to machine production. Industrial operations in which machinery is the chief factor are directed toward producing the

greatest possible quantity of a uniform quality; therefore, as far as inventive skill will allow, the machine and natural forces, rather than human skill and energy, are employed in producing goods which satisfy the common needs of all men. The class of work in which skill is the determining factor aims to improve the quality rather than to increase the quantity produced. As the demand for the latter class of goods increases the call for skilled workers will also increase.

There are indications of a revival of those industries involving more skilful hand work. More interest is being manifested, throughout the country, in art, architecture and the products of the various handicrafts. The increased attention paid to art and drawing in our public schools is another indication of the coming change in the spirit and demands of the American people. The result of such training on the next generation will be great, and its effect cumulative on the succeeding one. Industries involving artistic ability and intricate manual skill are incapable of minute division of labor. The gain resulting from the centralization of industry and the division of labor is very small in this class of work. It is well adapted, however, to small factories and workshops, and forms an appropriate kind of industry for small villages. If there is to be any considerable revival of village industry, it must come through an increase in the demand for the products of skilled manual work.

The use of steam and the lack of adequate rural transportation facilities forced the abandonment of village industry and built up the existing great industrial centers. In recent years the increasing use of electricity for the distribution and application of power is changing the location and internal arrangement of our shops. This, together with the rapid growth of suburban and interurban electric lines, is placing the villages and rural community in a better condition for industrial pursuits. The separation of agriculture and manufacture will, as a result, probably be less in the future than in the present or the immediate past.

Two great forces, in addition to the work of the school, may be discerned to be removing the obstacles in the path of the arts and crafts movement—the decentralizing tendency of electricity when used to transmit power, and the growth of the labor movement which demands shorter hours and better shop conditions. Just as the manual training movement was a result of economic and industrial changes, so is the call for art in the crafts the result of such forces. As the machine displaces workers, they are pushed higher up in the industrial scale. Such a phenomenon must also be accompanied by an increased demand for the products of skilled workers. This movement is not something evolved out of the minds of a few thoughtful devotees of art; but is in harmony with and dependent upon the needs of industrial and educational life. It is an evolutionary movement.

SOME PLANTS WHICH ENTRAP INSECTS.

By FORREST SHREVE,
THE JOHNS HOPKINS UNIVERSITY.

WE seldom give a thought to the fact that plants need food. They lead such mute, motionless lives that it is difficult to believe that they have, like ourselves, a bread-and-butter problem staring them constantly in the face. We watch the geraniums and begonias of our window-garden grow and bloom with nothing to nourish them but a few handfuls of earth and a little water. Surely their food problem must be a simple one if the substances necessary to the formation of stem and leaves and blossom can all be got from so little earth. Wherein lies all the difficulty about poor soil which besets the farmer, and why must he buy tons of plant food and drill it carefully into the ground in order to get a remunerative crop of grain? The whole trouble for the farmer arises from the scarcity in the soil of two or three food elements which, although highly important, form but a small part of the total weight of growing plants. The foremost of these scarcer foods, nitrogen, has been a source of difficulty not only to man, but to a large number of plants as well, which have been forced to adopt a means of getting it which is radically different from all other methods of plant nutrition, so much so indeed that it was long looked upon as a mere meaningless 'freak of nature.' This method is the catching of insects.

Every one has heard of the pitcher-plant or perhaps seen its urn-like leaves half filled with water. Innocent looking as are these leaf-pitchers, and casual as may seem the presence of three or four drowned flies in the water which they contain, yet in truth each pitcher is a veritable trap, clever in design and effective in its purpose of alluring and drowning insects. Different in look, but to the same purpose, are the leaves of the sun-dew. Its bristling hairs bear beads of jelly, not for the mere splendor of their dazzling brilliance, but to allure, catch and hold fast gnats and mosquitoes, all to the same end as in the pitcher-plant,—supplying a shortage of nitrogen in the food. Not these two plants alone, but a large group of nearly four hundred species, are insect trappers, carnivorous or, as they are more commonly called, insectivorous plants. The varied devices which these plants possess for alluring insect prey, catching, holding and utilizing it furnish matter for one of the most interesting chapters in all botanical science.

Perhaps no one of the insectivorous plants possesses what may be more truly called a trap than does the bladderwort (*Utricularia*). This is a floating aquatic plant without roots, confined to pools and quiet streams where it is in no danger of being washed away. Borne thickly upon the fine leaves, and like them entirely submerged in the

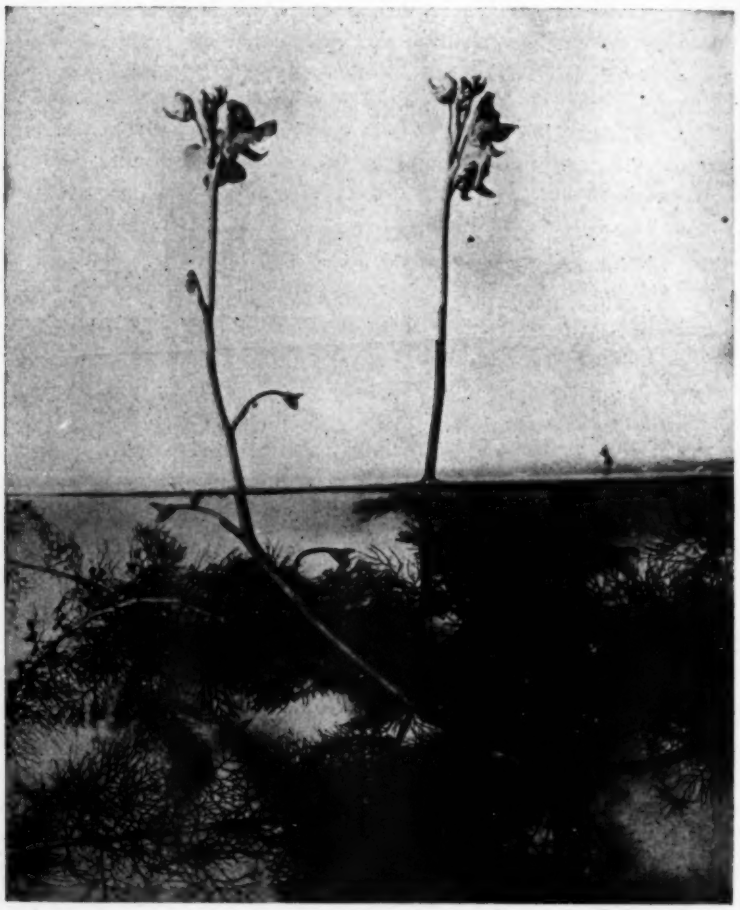

Fig. 1. THE BLADDERWORT IN BLOOM. At the left may be seen the traps.

water, are the traps, minute hollow globular structures bristling with hairs at one end. Buried among the hairs is the entrance to the trap. Swimming about in search of food or in an attempt to escape from enemies, some minute crustacean or insect larva will push in among the hairs. Spying the entrance, it will dart forward and striking the almost transparent door it will unwittingly pass into the trap. But the door has instantly sprung shut again and vain will be all the efforts of the prisoner to make an escape. Starvation soon ends its struggles,

death is followed by decomposition, and in the absorption of the products of this the plant accomplishes the end for which it possesses the traps—it gets its needed nitrogen.

In the pitcher-plants the urns of water are set and all else is left to the curiosity of the insects, the inner structure of the leaf being such—as we shall soon see—that a secure trap-door is not needed. The half dozen species of pitcher-plant (*Sarracenia*) exhibit considerable variety in the form of their leaves. In the purple species, the only one growing north of Virginia, the leaves form a rosette-like cluster procumbent on the mud or moss and bent upward so as to give the mouth a horizontal position. The stalk is exceedingly short and the leaves, heavy with water, never rise above the surface of the swamps and bogs which are the only home of the plant. At blooming time a stalk is sent upward for a foot or more, bearing the curious leathery flowers which nod to one side in a manner which has led some one of vivid imagination to call this the 'side-saddle plant.' The water which fills all but the youngest of the leaves is simply rain-water which has fallen in, and has nothing to do with the water supply of the plant in the ordinary sense. In the water are pretty sure to be some struggling insects trying to float or to crawl up the sides of the pitcher, some others whose struggles are over, and the remaining legs and wings of still earlier victims. All sorts of flying and creeping things seem to have a natural curiosity to examine hollow caverns such as the pitchered leaves appear to them. Perhaps, too, they are drawn to the plant by its rich red coloration or the striking veins which mark the mouth of the pitcher; indeed, one botanist has found drops of honey arranged in a row up the side of the pitcher, a lure to guide the steps of the insect directly to the interior. The wing which runs up one side has been thought, too, to serve a use in preventing insects from crawling round and round the pitcher, and to direct their steps upward to the slippery edge of the mouth. Once falling from the edge into the water, slim indeed, is the chance that any but the most active of insects will get out. The sides of the interior are not only steep, but are exceedingly smooth and offer no foothold by which to regain the top. And even if the bedraggled creature should succeed in crawling up beyond the slippery zone it would encounter an array of long stout hairs crowded close together and pointing downward. Over this ambush none but the most long-legged of insects can crawl, and

FIG. 2. A LONGITUDINAL SECTION OF A BLADDERWORT TRAP GREATLY ENLARGED, SHOWING THE HAIRS, THE MOUTH AND THE TRAP-DOOR.

they are the very ones least likely to have ever got up the slippery zone. Wet and exhausted, they fall again into the water, where they soon drown and yield up the substances of the body to be absorbed by fine hairs lining the bottom of the cup, and given over to the nourishment of their passive captor.

Some of the southern species of pitcher-plant have leaves standing erect as much as two or three feet in height and furnished with a lid-

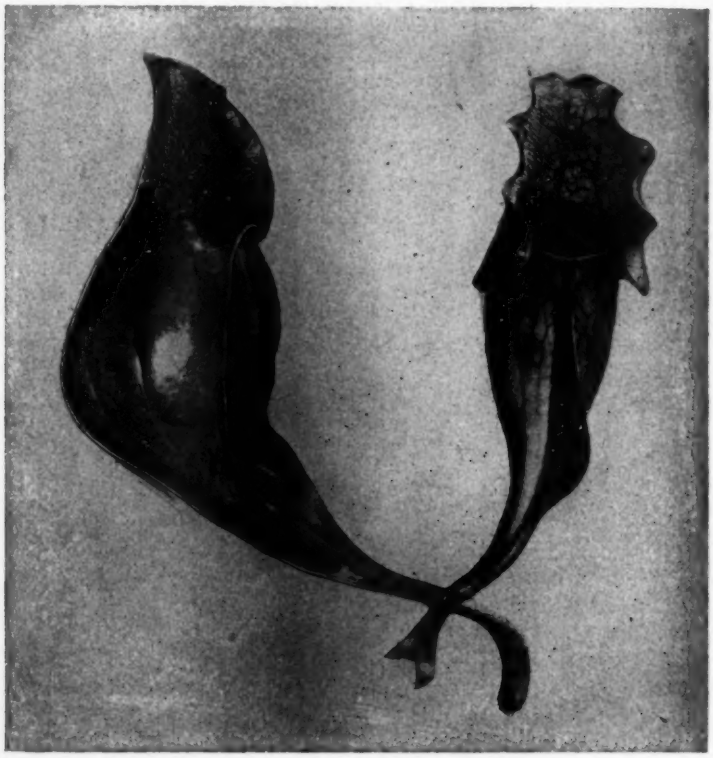

Fig. 3. LEAVES OF THE PURPLE PITCHER-PLANT. The one at the left is cut in half to show the interior, with the downpointing hairs at the top, the slippery zone (betrayed by the highlight), the absorbing hairs at the bottom, and the dark mass of insect remains.

like covering, not indeed a trap-door to shut down over the mouth, but serving to keep the rain from completely filling the pitchers and breaking them down with its weight, a provision which the purple pitcher-plant does not miss because of the prostrate position natural to its leaves. In other species the leaf is furnished with a hood arched over the mouth so as almost to conceal it, brightly colored with yellow or red, or marked with translucent spots. In the Californian pitcher-plant (*Darlingtonia*), a rare and local species, the leaf is hooded and the entrance small, but accompanied by a hanging pro-

jection shaped like the tail of a fish. The hood is marked opposite the mouth by a number of translucent spots which some botanist has imagined are false windows, against which entrapped flies bump their heads in a wild effort to escape, being thus diverted from the real opening!

In the swamps and along the streams of the rich tropical forests of Borneo, Java and Ceylon are found the East Indian pitcher-plants (*Nepenthes*), a group in many ways more highly developed than their American relatives, for there are forty species of them, all plants growing to a considerable size and several of them forming important constituents of the vegetation. The stem is erect or half-climbing, with long narrow leaves tapering to slender ends, which will twine like a tendril about any supporting twig or stick and then give rise to a single pitcher, or failing to find a support, will fail too to produce the pitcher. In variety of design, brilliance of color and showy contrast of spots and stripes the East Indian pitchers far outdo those of the American plants. They are provided too with elaborate lids and covers which here have a double meaning, for the pitcher is not filled with rain-water, but with a secreted water of its own, which must not be diluted by the rain, as it contains precious substances given out with the water from glands in the bottom of the pitcher. The most important of these substances is a digestive principle much resembling the pancreatic juice of the human stomach; and scarcely less important is a faint trace of hydrochloric acid, without the presence of which the digestive juice can not work, for it is not here for any idle purpose, but for the business of digesting quickly the abundant prey which tropical insect life affords. A fly which falls into a glass of water is often able to escape because the close-set hairs covering its body do not permit it to become thoroughly wet. In the liquid of the pitchers is another substance known as azerin, the property of which is to cause any hairy surface to become quickly wet, which means for the fly sure drowning.

Fig. 4. Drummond's Pitcher-plant of the South, with its Covering Lid and Showy Marking.

Here are pitfalls, then, not very unlike those of the American pitcher-plant in their mode of decoying victims and preventing their escape, but far advanced over them in their action, for the digestive juice yields up the nourishing substance of the insect much more rapidly than does the process of decay, and far more economically too, thus increasing the amount of the plant's food, and thereby its abilities for growth and reproduction.

The closed trap and the pitchered leaf are not the only devices for insect capture which we find among plants; they also possess devices which man has closely paralleled in his invention of fly-paper. These

Fig. 5. Leaves of the Parrot's-beak Pitcher-plant, with its Hidden Mouth. The coloration is white and red.

are, in general, sticky secretions borne either upon a flat leaf surface or on the ends of hairs arising from leaves. The plants possessing snares of this sort are more numerous than those with pitchers, and quite as successful as the latter in obtaining a generous supply of nitrogenous food.

Simplest of this class of the insectivorous plants is the butterwort (*Pinguicula*), a small annual, not unlike some of our commonest violets in appearance. A dweller in high mountains and the cold bogs of the north, it is particularly well known to every one who has climbed

about in the Alps. The leaves are broad and undivided, slightly inrolled at the edges and coated on the upper surface with a sticky slime exuded from minute groups of glandular cells. An insect alighting on the leaf is caught and held by the sticky secretion, and the more it struggles to escape the more firmly is it held and the more completely does its whole body become involved. If the insect has chanced to alight near the edge of the leaf the inrolled margin will roll still

Fig. 6. Flower of the Parrot's-beak Pitcher-plant.

further so as to cover it completely, but whether near the edge or not, there is something in the contact of this available food which causes the excretion of juice to be so abundantly renewed as to be sure to envelop the insect. In the renewed excretion there is to be found a digestive principle such as occurs in the pitchers of the East Indian pitcher-plant, so the captured prey, soon smothered to death, is also rapidly consumed and its essence carried into the leaves by means of the glandular secreting cells.

It is of interest that the only case in which any of the insectivorous plants have been found of practical use is in connection with the presence of the digestive juice in the butterwort. There is associated

with it here, as in the stomachs of animals, a coagulating principle, a rennet. In some manner difficult to guess the shepherds of the Alps learned years ago that the leaf of the butterwort placed in fresh milk would cause it to thicken rapidly, and to this day they use these leaves rather than the animal extract in the making of curd for cheese.

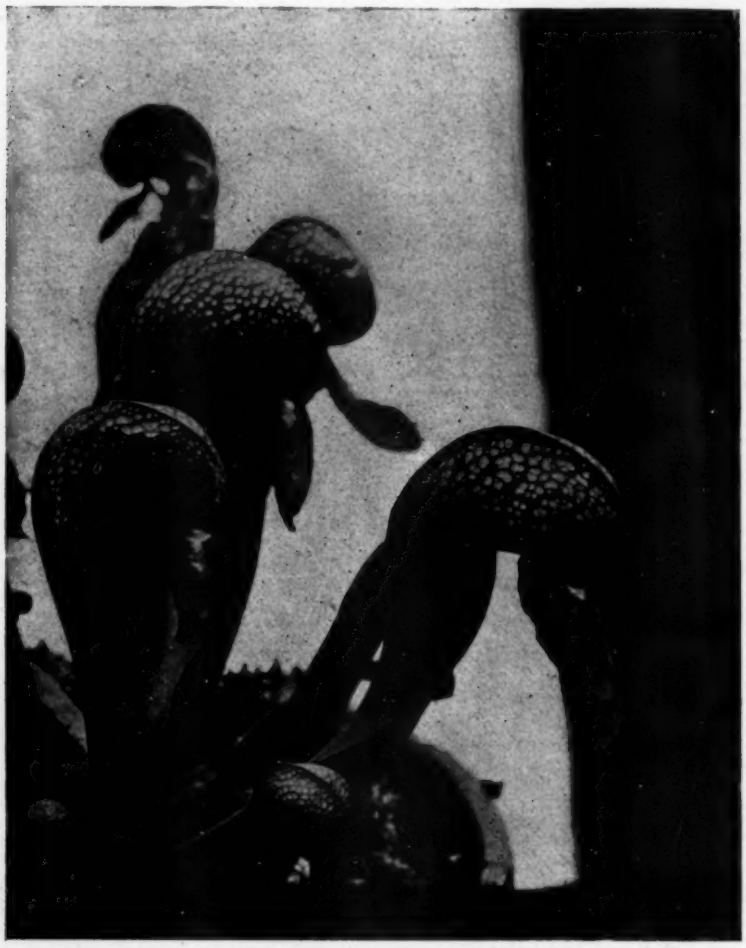

Fig. 7. THE CALIFORNIAN PITCHER PLANT. The white spots are the false windows, and in the head to the left, which has been torn open, may be seen the mouth, situated just behind the hanging appendage.

The sun-dew (*Drosera*) is one of the best known of the insectivorous plants of this class, both because of the wide distribution of the ninety species over the world and on account of the detailed and patient study of it which was made by Darwin, whose book 'Insectivorous Plants' is a rich mine of information for any one interested in

this subject. Our commonest sun-dew in the eastern United States (*Drosera rotundifolia*) is a delicate little plant without stem—a mere rosette of long-stalked leaves with rounded blades. Bristling from the upper surface of the leaf stand thirty or forty stout hairs nearly as long as the diameter of the leaf. At the end of each hair is a swollen gland surrounded by a globule of viscid jelly, the whole scarcely as large as a pinhead. There are few more beautiful objects in the

Fig. 8. The East Indian Pitcher-plant.

plant world than a leaf of the sun-dew with its clear beads of jelly flashing in the sunlight against a rich setting of green and red. This splendid sight lures the small gnat or fly into contact with one or more of the beads and gives the jelly a tenacious hold on some particular leg or wing. The contact causes a disturbance to be set up in the leaf which brings the other hairs to bend towards the ones which have secured prey. If the insect caught is a minute one only a few of the hairs will be aggregated in this manner, but if a larger

one has become entangled all the hairs will take part in the movement, and even the blade of the leaf may be bent together in such a way as to aid in the aggregation of the tips. The globules of jelly fuse into a mass about the insect and there is poured out from the glands a digestive juice such as that in the East Indian pitcher-plant and the butterwort. All the soft parts of the insect are digested and the nutritive juices, rich in nitrogen, are absorbed by the very same glands which secreted the digestive juice.

It is obvious that the aggregation of the hairs causes a more complete surrounding of the insect with jelly, increases the amount of digestive juice brought to act upon it, and also the number of channels for conducting the juices back into the leaf. The movements here involved are comparatively rapid —the hairs nearest the one which has made a capture begin to move in five seconds; if the capture is a big one all the hairs will be aggregated about it in half an hour. The time required for the digestion of prey depends entirely upon its size and nature; when completed the jelly dries off from the glands, the hard indigestible parts of the insect blow away, and the hairs resume their usual positions. The globules of jelly are then renewed and the leaf is ready for another capture. A single leaf may partake of above one hundred such meals, but more commonly its life is shorter, its place being rapidly taken by a younger leaf.

Fig. 9. THE CUP OF ANOTHER SPECIES OF EAST INDIAN PITCHER-PLANT. Note the two directive wings on the outside and the ridge just inside the mouth.

These are highly complex structures with which we meet in the sun-dew, and the united action of the hairs in aggregating themselves towards the spot where an insect has alighted is an example of co-ordinated activity such as is rarely met with in the plant world. There are, however, no unusual structures here, there is nothing in any way resembling a nervous system and nothing suggesting any similarity to the coordinated movements of animals which they so closely resemble.

The most highly developed and remarkable of the insectivorous plants is the Venus' fly-trap (*Dionœa*), which will never cease to be the cardinal attraction with all florists so fortunate as to be able to

humor it into healthy activity. It is one of our rarest American plants, being found only in the bogs of a restricted area on the coast of North Carolina.

In the Venus' fly-trap, as in the East Indian pitcher-plant, only a portion of the leaf has been modified for insect capture,—a rounded terminal portion cut off from the leaf proper by a constriction, and hinged along its midrib so as to be capable of closing like a book. On this portion, the 'trap,' are three sorts of hairs essential to its operation

Fig. 10. THE SUN-DEW IN BLOSSOM, GROWING IN A HUMMOCK OF PEAT-MOSS.

—the first long and stout, fringing the edges of the two lobes, the second but six in number, three in the center of each lobe, and the third minute, innumerable ones covering the entire inner surface of each lobe.

If an insect alighting on a fly-trap leaf chances to touch any one

of the six slender hairs or to alight on the triangular area on either lobe which is bounded by the three hairs, the lobes of the trap immediately begin to close together. In perhaps as short a time as five seconds they have shut on the luckless insect, the stout marginal hairs have formed an interlocking fringe about the edge of the trap, preventing its escape, and the small hairs have begun to pour out digestive juices upon the hitherto dry surfaces of the lobes. Any touch, pres-

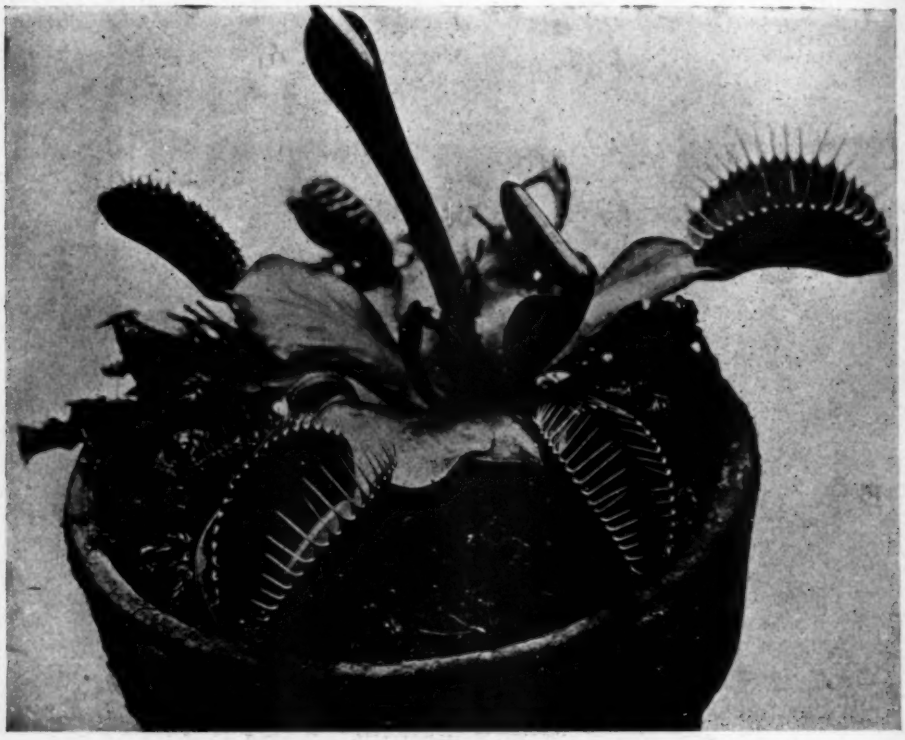

Fig. 11. The Venus Fly-trap.

sure or wound on the slender hairs or on the triangular areas will cause the lobes to close, whether the touch be that of an insect or that of an inanimate object. The other portions of the trap are so much less sensitive that it is necessary for them to be some time in contact with a nitrogenous substance in order to bring about closing of the trap. The contact of raindrops on any part of the leaf is without effect, and the other parts of the plant are entirely without sensibility. Still more effectually is the entrapped insect surrounded with the digestive juices than in the sun-dew, but the complete consumption of its soft parts may take many days. On reopening after a capture the trap will be torpid and unresponsive for some time, but if it has chanced to close

without getting a meal it will open within twenty-four hours and will be at once ready for a capture. The number of times that a trap will close and digest nitrogenous food is comparatively few; its delicate organization is soon worn out and ants may crawl over its face with impunity.

There is a wealth of interesting variety among other species and genera of the insectivorous plants, but the few described may well stand as examples of the whole number, for none depart very far from some one of these in the build and working of their pitfalls. While some of the traps are simple in structure and slow in action, and others are complicated and swift, yet there is a compensation in the fact that the more complicated devices are the most short lived.

The plants of insectivorous habit are not all members of a single family, and indeed are not all closely related—the group is a purely physiological one and owes its coherence to the fact that in all its members the meaning of the capture of insects is the same—the supplying of nitrogenous food. The very natural and pertinent question here arises: Why do these plants need such a remarkable means of getting nitrogenous food when other plants get on so well without this means? The insectivorous plants are obviously not able to subsist on insects alone, and—at least in the beginning of the habit—they were not different from other plants in their needs for nitrogenous food. So far as concerns the manufacture of starch and other non-nitrogenous foods the insectivorous plants are like all other green plants, deriving their carbon from the atmosphere, their hydrogen and oxygen from the water of the soil. It is in the elaboration of its more complex foods and the building up of new living substances in the process of growth, and particularly in the maturing of seed that a plant meets its need for nitrogen. In the ordinary plant this supply of nitrogen is derived from the nitrates which, together with several elements needed in small quantities, are brought up by the roots from the materials dissolved in the water of the soil.

Now, insectivorous plants in all parts of the world are found growing only in peat bogs, swamps, undrained pools and ditches—places in which it has been found that the water about their roots, from which they would be expected normally to draw their supply of nitrogen, is exceedingly poor in nitrates. Higher compounds of nitrogen exist in such places in plant and animal remains, but fail to be reduced to nitrates because of the absence of certain kinds of bacteria which carry on this work in all ordinary soils but are absent here because of the lack of drainage and consequent non-aeration of the water. It is this deficiency in available nitrogen, then, that is made up by a diet of insects, which are of course rich in nitrogenous substances.

How have such complex structures as those of pitcher-plant and

sun-dew had their origin in the course of the evolution of the plant world? Such a question will ever remain a mystery, and on its solution we shall be able merely to throw an occasional ray of light. Very many plants have their stems or flower-stalks beset with glandular hairs secreting sticky substances; an example in point, the clammy cuphea of our fields which sticks to the fingers tenaciously if we attempt to pluck its flowers. So far as known, the sticky secretions serve the plant in no way other than making it unpleasant browsing for herbivorous animals and ridding it of marauding ants, which become stuck to the glands and seldom escape. Might not such a condition have existed in the ancestors of the sun-dew? Might not the accidental catching of insects in this manner have formed the starting-point for the habit which is now so essential to the plant? Pitchered leaves are found too in many plants, and in many of them catch insects by pure accident, for example, the *Dischidia* of the East Indies. It is quite possible that further study of such cases may reveal new examples of the insectivorous habit, or may discover plants which have an imperfect or partial dependence on insect food, and any such discoveries would throw light on the development of the habit in its full-fledged possessors.

Marvelous as are the adaptations of the insectivorous plants, they have not been all these years upon the earth without certain crafty insects having learned not only to escape falling a prey to them, but to use them to their own ends. The pitchers of the Californian pitcher-plant are the home of a small moth which is provided with sharp spurs on its middle legs, which enable it to crawl easily over the slippery surfaces of the interior. So fearless has the moth become that it even lays its eggs in the interior of the pitcher, and here, protected from all the manifold dangers of the outside world, they hatch out in security. The young caterpillars spin a web over the slippery surfaces and the projecting hairs, making a safe path for themselves to the outside. There is a blow-fly which is able, too, to crawl over the slippery surfaces by aid of peculiar claws which give it a good sure footing. The grubs of this fly hatch out in the water of the pitcher and, far from yielding themselves up as food, they live here their brief term of larval life, and escape by boring a hole in the side of the pitcher.

In the South African hills grows a sort of bushy sun-dew, known locally as the 'fly-bush' (*Roridula*). This plant is a large consumer of insect food, owing to its size and the completeness with which twigs and leaves and even parts of the flower are covered with glandular hairs. Among its branches a spider has been found to spin its web. Not content with the supply of flies from its web, however, the spider goes forth upon the twigs of the fly-bush, and walking about in safety

among the glands, pulls off such insects as it desires and either devours them on the spot or returns with them to its web. Not less wonderful is the fly which pollinates the flowers of the fly-bush. It, too, is enabled, by possessing long legs, to walk in safety among the glandular hairs, and it takes pay for the service of having pollinated its flowers by puncturing the leaves and with its long proboscis sucking the juices of the plant.

So far as may be judged from rather limited observations the spider and the fly of the fly-bush are not found on any other plants. The spider has probably been attracted from other homes by the rich feeding ground, and, as for the fly, no one knows how complex may have been the history of its evolution. What more complicated relation between plant and animal can be imagined than this of the fly and fly-bush? A plant in need of nitrogenous food possesses effective traps for insects, from which this food is got. The plant is in need, too, of the services of insects for the pollination of its flowers. How can this plant, a death trap to insects, secure their service in pollination? Its large showy flowers attract many insects, but they find no honey to reward them for their visit, and if they linger about the plant their doom is sealed. The flower is not without honey, but the cells containing it are covered by a layer of ordinary cells, and when the long-legged fly makes its visits to the petals its proboscis is brought into use, the layer of cells is punctured, and the honey obtained. Insured against harm the fly may then visit other parts of the plant, and here it will use its proboscis again on leaves or stems to plunder the plant of its sap.

How much akin these phenomena are, you will say, to bribery, deceit and the taking of unfair advantage. True, there is no altruism among the lower forms of life; the benefit of self and of posterity is the supreme good of the animal and of the plant, and necessarily so by reason of the multitude of competitors and the keenness of the strife with them. Yet the great mass of plants live independently and, so to speak, honestly; overcoming obstacles and withstanding reverses, doing no more than energetic men in jostling their neighbors in the winning of a livelihood, and being no more than normal in providing that their own offspring should have a good start in the world rather than the offspring of their neighbors.

HEBREW, MAGYAR AND LEVANTINE IMMIGRATION.

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Hebrew Immigration.

THE persecution of the Hebrew race finds no parallel in history. Other races have suffered at the hands of the conqueror, but these other persecutions are transient and intermittent compared with the persistent persecution to which the Jew has been subjected for centuries. One thousand years before Strongbow landed in Ireland, Titus destroyed Jerusalem, slaughtered thousands of its brave defenders and carried many thousands more as prisoners to fight the beasts in the arena or serve as slaves in the Roman galleys.

It may be said that persecution of this race has never since ceased. No century of the christian era passed without its record of persecution of the Jew. Adrian, Trajan and their successors kept up the work begun by Titus, and the first real respite from persecution was secured to the Jew by the conquests of that Semitic conqueror, Mahomet. But while the Jew was respected and his work in science and letters encouraged by the Saracens in Asia and Africa, he was being persecuted consistently by christians in Italy, Spain, France, Germany and England. This persecution continued throughout the period of the Crusades and down to the beginning of the nineteenth century.

Napoleon I. was one of the first sovereigns in Europe to cease discriminating against the Jew, and extend to him the rights of citizenship. Since that time other countries, notably England, have removed the ban from the Jew. In Poland the Jew was not persecuted to any extent previous to the partition of Poland, but with the beginning of Russian domination in Poland and Lithuania, one million Jews came under the iron rule of the Czar. Jews had existed in Russia from very early times, but most of the Russian Jews of to-day are descendants of the Jews who lived in Poland and Lithuania before those countries became a part of Russia. When one reads of the history of the Jewish race, with its story of persecution, cruelty and discrimination, a feeling of wonder and admiration must be felt for this remarkable people, which, in spite of almost universal oppression, exists to-day as the purest racial type in the world, and which furnishes the world with more than its share of great men in finance, art, music, science and literature.

That the Hebrews as a race have survived at all is a tribute to their splendid vitality. Not least wonderful is the fact that they have developed a common language in spite of their widely scattered distribution, among half a hundred alien peoples. This language, called Yiddish, is a corrupt German, modified by the addition of Polish and Hebrew words and suffixes. By means of this language expressed in Hebrew characters, and read from right to left, the Jewish people have preserved an extensive literature, mostly historical and religious in tone.

The persecutions endured by the Hebrew in the past were exceeded in severity by the comparatively recent anti-Semitic outbreaks in Russia and Roumania, and in the consideration of the Hebrew immigrant we are chiefly concerned with Russian, Roumanian or Galician Jews. German Jews formed a part of the great German exodus of the eighties, but to-day they, as well as the Hungarian Jews, are seldom seen among the immigrants.

The Jews moved eastward from western Germany and the Rhine valley under stress of persecution of the middle ages. They were welcomed by the kings of Bohemia and Poland and grew in numbers and prosperity in those countries until Bohemia came under the dominion of the House of Hapsburg, and Poland was divided between Russia, Prussia and Austria. Since the partition of Poland, the Jews have suffered, as well as the Catholics of Lithuania and Poland, from the religious enmity of the Russians. During the reign of Czar Alexander II., the stringency of oppressive anti-Semitic measures in Russia was relaxed, and the condition of the Jews in Russia was much improved. The assassination of the good Czar Alexander II., an event entirely unconnected with the Jews, was followed by terrible anti-Semitic outbreaks in southern Russia, and by the tyrannical enactments known as the May laws of 1882. These laws provided that the Jews, who hitherto were permitted to live anywhere within the Jewish pale, which comprised a territory of over 300,000 square miles, were now forced to prove that they possessed their right of residence previous to 1882, or, in default of such proof, to move into the towns. Many Jews, owing to the relaxation of the laws under Alexander II., had established themselves without the pale, and these now were forced back to add to the confusion and misery of the inhabitants of the towns. Within eighteen months of the enactment of the 'May Laws' the population of the little town of Tchernigov increased from 5,000 to 20,000 souls, and this terrible overcrowding was as marked in nearly all other towns within the Jewish pale. The economic pressure in the towns, the consequent hopeless competition for existence produced by these edicts, can be understood, and conditions grew worse as the population increased.

The first great exodus to England and America began soon after the enactment of the May Laws, and, owing to the reign of terror existing in the towns, resembled an indiscriminate flight. After a time the traffic became organized through the activity of steamship agents, and, the economic causes still existing, the stream of emigrants has since been almost constant. In addition to the oppressive enactments, an absurd story of ritual murder has been circulated among the ignorant Slavic peasantry for the purpose of inciting anti-Semitic feeling. Michael Davitt, the Irish patriot and writer, after a recent visit to Russia, thus sums up the situation in his book 'Within the Pale':

> The murderous competition for employment, the deadly rivalry for existence, the bad blood between opposing races, the poverty and social wretchedness which such a condition of things would create—apart from the operation of coercive laws—can readily be imagined by the American reader. But this is no overdrawn picture of the economic anarchy prevailing within the Russian pale of Jewish settlement.
>
> The towns are crowded with artisans and traders, and as these are out of all proportion to the producers and consumers of an agricultural country, they necessarily become more destitute and wretched as their numbers increase. They are too poor to emigrate. They are prohibited from migrating. They can not seek work on land. They are not permitted to engage in several occupations.

Mr. Davitt asserts that the Czar can accomplish much for the Jews in his domain by destroying the legend of the blood atonement. He avers:

> M. de Plehwe and the Czar can accomplish one good and blessed work, if so minded, without altering a single anti-Semitic Russian law. The Emperor can destroy in Russia the atrocious legend about the annual killing of christian children by Jews as an alleged part of the blood atonement in Hebrew paschal rites. In this humane and christian task he is entitled to the cooperation of the Emperor of Austria, the King of Roumania, and the heads of the other Balkan states, where this story of ritual murder is constantly circulated, and not infrequently as a part of political propaganda. There ought to be a truly christian crusade waged against this infamous product of ancient, insensate, sectarian hate.

In Roumania the intolerant attitude of the government and a series of oppressive enactments against Jews constitute the chief cause of emigration. These measures of persecution employed in Roumania were in violation of the Berlin Treaty of 1878, which guaranteed religious liberty and equal rights to all. The Roumanian government maintains that the Jews are aliens, and to give them equal rights would mean that they would control the country in a few years.

Galicia under Austrian rule has no legislation against Jews in force, but a strong anti-Semitic sentiment exists, and no doubt this prejudice aggravates the economic problem which is the chief cause of emigration from Galicia.

Much is heard of assisted immigration, and no doubt the majority of Russian and Roumanian Jewish immigrants are assisted at some

point in transit, but it can be stated definitely that Jews in America neither individually nor collectively assist or encourage immigration to this country. They have sent representative men to Europe to confer with leading Jews of London, Berlin, Frankfort, Vienna, Paris and other centers in an effort to prevent wholesale emigration and to divert the stream from the United States. On the other hand, European Jews and Jewish societies, especially in England, have assisted thousands of destitute co-religionists and passed them on to America. Baron Maurice de Hirsch, the Rothschilds and other Jewish philanthropists have assisted the Jews to found colonies in Palestine and Argentina. In spite of these attempts to divert the stream from America, the bulk of the exiled European Hebrews land eventually in America. The American Hebrews realize that the chances for individual prosperity in the Hebrew immigrants depend upon their wide distribution. The more they congregate together, the greater the tendency to chronic poverty and pauperization. The success of the German Jews and Jews of other nationalities who came here years ago was due to their wide distribution, and competition with Americans in general, rather than the competition with each other for existence which is a necessary adjunct of life in the Ghetto. For these reasons American Jews, individually and collectively, are doing everything in their power to distribute their kindred over a wider area. In their work of caring for their poor they have encountered two obstacles which can be put down as the chief causes of the poverty of the Ghetto —one is the physique of the Hebrew immigrants and the other is their occupations. In physique they rank below all other immigrants, and few seem capable of hard physical labor. They seem to have no muscular development, and are prematurely old at an age when a German or Scandinavian is still in his prime. This poor physique is due to their living in the crowded quarters of cities and towns and to the occupations in which they have been engaged. These were conditions in Europe over which they had no control, as they were not only restricted as to residence, but were prevented by law from engaging in agricultural pursuits. Yet now when they are no longer subject to restrictive laws they cling tenaciously to the life in the slums, and their sweat-shop occupations.

Their occupation here is always some light one, requiring the least possible expenditure of physical labor. They are necessarily tailors, tinners, workers in fur and leather and other light occupations. They are physically incapable of any but the lightest kind of agricultural labor and have a distaste for that, as evidenced by the almost general failure of their attempts at rural colonization. One of the few successes recorded in the history of Jewish rural colonization was only made possible by the establishment of a clothing factory, to which

industry the erstwhile farmers took as naturally as a duck to water. From 65 per cent. to 70 per cent. of these immigrants of poor physique remain in New York City, to add to the congestion of the lower east side. Of the remaining 30 per cent. the majority go to Baltimore, Philadelphia, Chicago and other large cities, where they are rapidly building up Ghettos similar to that of New York.

The geographical distribution of the Hebrews landed in New York during 1903 is shown in the table given below.

State.	Number of Hebrews.	Ratio to Total Hebrews Landed.
New York	50,945	67 per cent.
Pennsylvania	8,206	11 "
Massachusetts	4,130	5 "
Illinois	3,170	4 "
New Jersey	2,004	3 "
Ohio	1,521	2 "
Maryland	1,074	1.5 "
Connecticut	1,020	1.5 "
All other states	4,133	5 "
Total	76,203	100 per cent.

Four fifths of the male adults are skilled in some light occupation, and this fact, coupled with their physical incapacity for hard labor, forces them into the sweat-shop. The addition each year of thousands of these sweat-shop workers to the lower east side of New York has produced a condition of affairs that beggars description.

Manager Frankel in 'The Twenty-seventh Annual Report of the United Hebrew Charities of New York,' October, 1901, says:

> No matter how earnestly we labor to care for the Jewish poor, already in our city, our burdens are being constantly increased by the thousands who come from Europe every year and settle in our midst. It is worth noting in passing, that, comparatively speaking, few of these newly arrived immigrants come to us for assistance until after they have been in New York for a year or two. Either they have sufficient means of their own to bring them to America and to support them for a period after their arrival or they have been sent for by relatives, who are able to give them assistance for some time.
>
> But the evil conditions of the houses and the deteriorating influences of the sweat shops of the great Ghetto soon work havoc among these people, and after an interval of two or three years they come to us in numbers for relief. . . . Furthermore, in line with our belief, that the ounce of prevention is worth a pound of cure, and that as law-abiding citizens of our country, we should not run against public sentiment nor pose as violators of the law, we have come to an understanding with the London Board of Guardians whereby the unwise shipment of Jewish immigrants, who are not adapted to conditions of life in this country, will be stopped. Hitherto we have had to bear the burden which should properly have been borne by our British co-religionists. They were perfectly willing to furnish free transportation to those persons who were unable to make a living in England, but who believed if they could only reach the shores of America (which means New York to all Jewish immigrants) their troubles would be at an end. . . .

What do these figures [here omitted] mean? The answer is easily given, and is but a repetition of the statements made to you in these annual reports for the past few years. They mean, if they mean anything, that a condition of chronic poverty is developing in the Jewish community of New York that is appalling in its immensity. Forty-five per cent. of our applicants, representing between 20,000 and 25,000 human beings, have been in the United States over five years; have been given the opportunities for economic and industrial improvement which this country affords, yet notwithstanding all this, have not managed to reach a position of economic independence. Two thousand five hundred and eighty-five of the new applicants, representing seven per cent. of the Jewish immigration to the United States during the year, found it necessary to apply at the office of the United Hebrew Charities within a short time after arrival. It must be remembered, furthermore, that the United Hebrew Charities does not represent the entire Jewish poverty and dependence that exists in New York City. Frequently our relief bureau is the place to which the applicant comes only after exhausting every other possible means of procuring assistance. When the numerous small relief societies, chevras, lodges, benefit societies, synagogues, individuals and others can no longer contribute, then and then only in many cases is the cooperation of the United Hebrew Charities sought.

If, besides the 50,000 people who applied at the United Hebrew Charities, we were to include in the dependent classes all who needed service of dispensaries, hospitals, asylums and institutions of all kinds or who were assisted by charitable effort other than that given by us, the statement can safely be made, that during the year from 75,000 to 100,000 members of the New York Jewish community are unable to supply themselves with the immediate necessaries of life.

The Hebrew has succeeded in America whenever he has separated himself from the Ghetto, and once away from all its influences Americanizes much more readily than is generally supposed. Other obstacles are in the way of transferring the Jews from the Ghetto to the country. The natural desire to be with their own people—to hear their own language, to be able to observe all their religious and social customs without fear of ridicule or interference, which the Jews possess in common with other alien races—make it difficult to get them away from the Ghetto. Then, too, the remuneration from agricultural pursuits is not enticing, and the opportunities for education and advancement to be found in the cities attract the Jew as well as the thousands of our native rural population, who flock to the great cities every year.

The hope for future betterment of conditions in the Jewish quarter of New York will lie in temporarily checking the Jewish immigration to this country, and in thus giving the Hebrew charitable organizations time to adjust conditions in the congested area. At present the good work performed in one year by finding places for poor Hebrews in other parts of the country is nullified the next year by the influx of thousands of new arrivals of the same character. If the stream of Hebrew immigration could be diverted for a time, those already here with the ample assistance of their charitable co-religionists might be distributed and made independent of charity. The realization of the dream of Zionism would tend to this result. Zion would hardly attract many Jews from

America, but it would receive the bulk of the Russian and Roumanian emigrants, and thus relieve the pressure here.

Two facts concerning the physique of the Hebrew race in general have been frequently noted. These are their longevity and their freedom from consumption. These facts seem rather inconsistent with the known poor physique of the Jewish immigrant. The first can be explained by their abstinence from hazardous occupations, their relative immunity from tenement house conditions, and the care which the Jews bestow on their sick. The freedom from consumption claimed for Jews in other parts of the world can not be said to obtain in New York. Consumption is very prevalent among them and is probably due to a combination of climatic influences and their manner of life in the Ghetto. Tenement house conditions alone could not explain the relative frequency of consumption, because they have been exposed to just such conditions for centuries.

The physical inferiority of the Jews is partially offset by their mental capability. Their intellects are sharpened by centuries of mental training. They possess in a remarkable degree the power of concentration of mind upon the object to be attained and a dogged pertinacity that spells victory for the student. They will deny themselves anything to obtain an education, and, when they have the opportunity, occupy a prominent place among students in every branch of study.

The Magyars.

The tiresome routine of inspection at Ellis Island produces varied effects upon immigrants, according to their temperament or race. Slavs drift through with blank faces and animal-like docility. The diminutive representatives of the Latin races appear frightened, but their faces are alert, eager, watchful. The Irishman treats the whole matter as a huge joke, and passes the inspectors with his cap on one side of his head and wearing a broad smile. The Magyar differs from all others, no halting hesitation in his gait, no evidence of terror or uncertainty, but he walks with military precision and confidence and something of a challenge in his bold defiant eyes. In short, he evidences the carriage of the trained soldier and the unconquerable spirit of a proud, warlike people.

About the close of the tenth century we find the Magyars established in what is now Hungary, under the leadership of Arpad. They undoubtedly came from east of the Carpathians at this time and came originally from the Finno Ugric cradle in western Siberia. They were probably akin to the 'Huns' who devastated Europe under Attila in the fifth century. Like the Huns they were absolute barbarians and carried war and pillage during the first century of their advent through the countries to the west and south. They were finally defeated by

Otho the Great of Germany and forced to accommodate themselves to a settled, peaceful existence. They adopted christianity and western political institutions and showed themselves as progressive in civilization as they had been skilful in war and pillage. The last of the line of Arpad, Andrew III., died childless in 1301, and the crown became elective. The first Hapsburg to be elected king of Hungary was Albert V. of Austria (1438), and the House of Hapsburg has since considered the kingdom of Hungary a part of its heritage. Owing to civil strife and rival claimants for the throne, the Turks obtained a foothold in the country about 1541, and their possessions were retained until finally driven out by Prince Eugene in 1718. The long stay of the Turks in Hungary was made possible by Magyar jealousy of the growth of Germanic influence. This feeling has never disappeared and was largely responsible for the brave defense of the young queen Maria Theresa by Magyars when her throne was threatened by Prussia, France, Bavaria and Saxony. After 1815 a great revival of national feeling was manifest among the Magyars. This movement was characterized by a demand for personal and constitutional liberty and a remarkable activity in literature. Many liberal reforms were achieved, but the suppression of the misguided revolt of 1848 set back the cause of national constitutional liberty twenty years. In 1867 the wise and good Franz Joseph saw the necessity of conciliating his Magyar subjects, accentuated by the humiliating defeat of Austria by the Prussians in 1866. The result was the dual monarchy as it exists to-day with a complete restoration of the constitutional liberties of the Magyar. Under the new order of things the Magyars have performed wonders in the establishment of commercial and industrial prosperity. Their progress in agriculture and manufactures, in railroad building and architecture, has been the marvel of Europe. And their economic progress and commercial expansion have earned for them the title of the Japanese of Europe.

From a country so prosperous and so greatly favored by nature as Hungary, we can scarcely expect to receive the best type of her subjects as immigrants. It is probable that the best type of Magyar has no inclination to leave his native land, and necessity compels but a very small number to emigrate. The Magyar immigrants are usually unskilled laborers and find employment chiefly in the mining states; 36 per cent. of their number landed being destined to Pennsylvania. Physically they are active and strong, and 90 per cent. can read and write. In fact, the Magyar seems an ideal immigrant but for one fault, his lack of permanency. Their intense national feeling and love for their native country make them, like the Englishman, slow to adopt American citizenship. They have a tendency to go back to Hungary and in flitting back and forth from Europe to America are

second only to those 'prize birds of passage,' the Italians. They are very industrious workers and rarely become public charges, so must be given credit for the amount of work they do, even if their permanency as citizens is open to question.

The distribution of Magyars landed in 1903 is shown by the following table:

State.	Number of Magyars.	Ratio to Total Magyars Landed.
Pennsylvania	9,701	36 per cent.
New York	5,291	19 "
Ohio	4,489	17 "
New Jersey	3,661	13 "
Connecticut	983	3.5 "
Illinois	760	3 "
Indiana	555	2 "
West Virginia	443	1.5 "
All other states	1,241	5 "
Total	27,124	100 per cent.

Levantine Races.

From the countries bordering on the eastern end of the Mediterranean Sea we receive several thousand immigrants each year, who are so far below all others in the matter of desirability that they are in a class by themselves. This scum of the Levant includes Syrians, Armenians, Greeks and Turks.

The Greeks are the best of this rather bad lot. Some few are producers and are engaged in textile industries, many more are peddlers and push-cart men. They establish Greek quarters in large cities and are probably under the control of padroni. Often when they are examined at Ellis Island, each member of a large party of Greeks will be in possession of the same amount of American money and all tell the same story, giving evidence of having been instructed and brought out in large parties by some one who probably controls their labor here.

The Syrians and Armenians are producers to a very limited extent in silk and cotton industries. The majority of Syrians and Armenians are engaged in trade, either as small shopkeepers or itinerant peddlers.

The activity of steamship agents in southeastern Europe and the establishment of a regular oriental steamship service from Marseilles to the Piræus, Beirut and Smyrna, have had much to do with the increase in Levantine immigration. Greek immigration particularly is stimulated by the enterprising Greek population of Marseilles, who reap handsome profit from the traffic, as all these oriental immigrants are landed at Marseilles and shipped from there overland to Havre, Rotterdam or other Atlantic ports.

The Syrians and Armenians ascribe as the cause of their expatriation the rapacity and misrule of the Sultan. Well-meaning American

missionaries have done much unwittingly to turn the tide of emigration from Asiatic Turkey to the United States. Young Syrians and Armenians educated here through the kindness of missionaries have advertised America, upon their return to Asia, as the land of promise, and thus increased our arrivals from Asia Minor and Syria. The majority of Syrian immigrants are orthodox Greek catholics, and very few Mohammedan Syrians come here. The Greek catholics or Maronite catholics will promptly espouse some form of protestantism in order to get their children into an institution. They are quite as ready to renounce the Greek religion for the Roman catholic for the same reason, to be rid of the responsibility of their young children. They always associate America in their minds with missionaries and charitable institutions. These traits have given the Syrian and Armenian a reputation for mendacity and lack of principle which can scarcely be said to be undeserved. The servile fawning humility and utter absence of spirit which these Syrians and Armenians exhibit are not attractive, and are but a pretense to cover the guile of the oriental. Bright young Syrians utilize religion to secure an education, then coolly repudiate all obligation to their missionary friends and engage in trade in the United States. The Syrian is averse to work of any kind, but he will never work at hard physical labor. He sends his wife and children out to peddle from door to door the oriental rugs, silks, laces and peddling truck. From peddling it is only a step to begging, and many of these peddlers combine the two vocations. The Syrian often goes into manufacturing small articles for this trade, using lofts in the Syrian quarter as work rooms, and employing men and women of their own race. They manufacture combs, brushes, hatpins, razor-strops, aprons, garters, suspenders, tooth-picks, crucifixes and other small articles for the peddling trade. The women earn from two to three dollars per week, and men make a little more, from four to six dollars per week. The Syrian women and girls also make the lace which they sell upon their peddling trips. The Syrian men and women peddlers make long trips from their headquarters, New York, and like true parasites follow in the wake of the rich to the seaside and summer resorts in the hot months, and to Florida or other parts of the South in the winter.

The Armenian immigrants, like the Syrians, are mostly traders, but a few are cigarette makers, and a small number are employed in the silk factories. Even the small percentage of these races employed as producers in the silk mills must be classed as unnecessary and competitive.

To the Greek, Syrian and Armenian quarters in New York, newly arrived immigrants go direct; and the congestion in these tenements is steadily increasing. The conditions which exist in the tenement of the Syrian or Greek quarters must be seen to be appreciated. No

words can describe adequately the overcrowding, the filth, the lack of air and sunlight, the ignorance of the common decencies of life and the miserable poverty of the tenement dwellers. The tenement headquarters of the Syrian peddler is crowded from the damp, miserable cellar to the garret with women and children, often a half dozen women, whose husbands are on the road peddling and whose children are in institutions, occupying one small room.

The physique of these races is very poor, and the percentage of loathsome or contagious diseases found among them is very high. During 1903, one Greek out of every thirty landed was sent back as likely to become a public charge. One Syrian out of every 28 was sent back for the same reason, and one Armenian out of every 58 was deemed incapable of making a living and sent back during the same period. In the matter of disease in 1903, one Syrian in every 100 and one Armenian in every 67 were sent back because of loathsome or dangerous contagious disease. One Greek in every 475 Greeks was sent back because of the same disability.

The mental processes of these people have an oriental subtlety. Centuries of subjection, where existence was only possible through intrigue, deceit and servility, have left their mark and, through force of habit, they lie most naturally and by preference, and only tell the truth when it will serve their purpose best. Their wits are sharpened by generations of commercial dealing, and their business acumen is marvelous. With all due admiration for the mental qualities and trading skill of these parasites from the near east, it can not be said that they are anything, in the vocations they follow, but detrimental and burdensome. These people, in addition, because of their miserable physique and tendency to communicable disease, are a distinct menace, in their crowded unsanitary quarters, to the health of the community. In their habits of life, their business methods and their inability to perform labor or become producers, they do not compare favorably even with the Chinese, and the most consoling feature of their coming has been that they form a comparatively small part of our total immigration.

The Greek immigration has shown the most marked increase, but Syrian immigration is also steadily growing, and without restriction, we may expect in the next few years, through the activity of the Mediterranean steamship agents, that many thousands of these human parasites will come here to reap the benefits of our civilization and increase instead of sharing our burdens.

MORE MEN IN PUBLIC SCHOOLS.

By RICHARD L. SANDWICK.

AMONG the recent movements in education, none is more worthy of notice than the call for more men in public school work. The proportion of women teachers has grown steadily. Fifty years ago the men engaged in school work outnumbered the women; the civil war reversed this, and the gap has widened every succeeding year. There are fewer men teaching to-day than there were in 1860, but there are four times as many women. Women will probably continue to do a greater part of the teaching. It is generally recognized that women are better suited than men to instruct young children; and there is certainly a place for them both as teachers and students all the way up from kindergarten to college. Women have exerted a softening and humanizing influence that is accountable in part for the change from the rough school of fifty years ago, from which the teacher was not seldom pitched into the road by his bigger pupils, to the happy, orderly school-room of to-day. Women teachers have accepted a salary of scarcely half what men of like capacity would have accepted. They have thus been the means of extending the public school system to a point far beyond what tax-payers would have borne if equal intelligence had been secured from men. For these and other services in education women are to be congratulated.

And yet we can not help believing that any further increase in the relative number of women teachers would not be to the interests of education. Women outnumber the men in high schools already; and below the high school they reign supreme. Many large city schools of grammar grade employ no men teachers. A majority of boys and girls never come under the instruction of men. There is danger in this of a one-sided development: both sexes are being educated by the sex whose relation to the political and industrial systems is not usually that of either voters or wage-earners.

Less than one woman in five is engaged in earning a living. Of these comparatively few are under the necessity of so doing. They seldom have persons dependent upon them for support, and not often would suffer if thrown out of employment. Their earnings are usually additional to the support given them by others and are regarded as supplementary to the family budget. Even when engaged away from home they can usually count on a father's support in case work fails. Marriage relieves most women of the responsibility of self-support, and

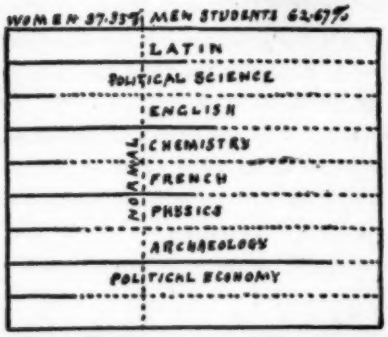
parents are willing to keep their daughters at home longer than their sons. The woman teacher has not been accustomed from early life to the thought that she must one day earn her living. She knows even after entering the school-room that her career as teacher is likely at any time to be cut short by marriage. Comparatively few women are wage-earners; the economic condition of the woman wage-earner is, moreover, quite different from that of the man; and the difference lies in the fact that the one is much less under the necessity of work than the other. It might naturally be inferred that the education of both sexes by that sex upon which the necessity of earning a living is rarely imposed would tend to keep economic considerations in the background. And it is true. Even in the higher grades economic independence is seldom a conscious aim; and the esthetic has a larger place than the useful. There ought to be more sympathy than there is for the boy with a yearning as he enters the age of adolescence to get out into the work-a-day world and earn a place for himself; a thing which the enrollment shows he is pretty likely to do if school does not prove that he will be the gainer by delay, or appeal to this side of his nature.

The presence of girls in the same classes with boys is not without significance here. It acts as a reinforcement of the same tendency away from the economic side which we have noted as a result of teachers exclusively women. A study of the tastes and preferences of women students in our universities, as indicated by the studies they elect, reveals the fact that they are not influenced to a great extent by economic forces. Women choose the purely cultural courses. A much larger proportion of them than of men study languages and literature; while very few take seriously to physics, chemistry, mathematics, political economy and political science.

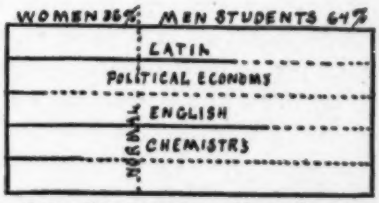
In the University of Chicago in 1900–01, there were 3,520 students registered in attendance, of whom 1,844 were men and 1,676 were women. The two sexes were thus fairly equal in point of numbers, the men out-numbering the women by 168. But in the language courses women greatly out-numbered the men. There were during the year 1,603 women studying English, and only 1,084 men; in French there were 468 women and 435 men; in Latin 621 to 430. In those courses which are more practical as being more closely associated with industry, the figures are reversed; here the men greatly out-number the women. In chemistry during the same year, there were 666 men enrolled and 120 women; in physics, 353 men and 90 women; in political economy, 354 men and 65 women. As showing that women are less interested in political and governmental matters, there were in political science only 68 women to 269 men.

These figures have been compared with statistics of other universities in the same subjects and they show a remarkable similarity. Where

the elective system is more freely allowed the choice of culture courses by women and of utility courses by men is still more marked. At the Leland Stanford Junior University in 1901–02, the number of students registered was 1,295, of whom 737 were men and 458 were women, the latter numbering only about three fifths as many as the men. Of the students electing English as a major subject, 156 were women and 58 were men; in Latin, 44 majors were women and 26 were men. On the other hand, in chemistry and economics the women made but a small showing; in the former there were 56 men to 13 women, and in the latter 62 men to 7 women. These figures will be more apparent in



CLASS ENROLLMENT BY SUBJECTS, THE UNIVERSITY OF CHICAGO.



CLASS ENROLLMENT BY MAJOR SUBJECTS, LELAND STANFORD JUNIOR UNIVERSITY.

the case of both universities cited, by reference to the graphs below. A large number of college women prepare themselves for teaching; it is probable that still fewer would be found in science courses if these were not demanded in the teaching profession.

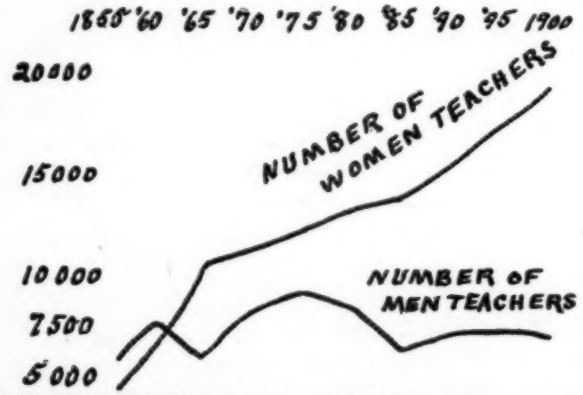
The great preponderance of girl students in our high schools coupled with the fact that more than half the teachers are women may account for the loss of ground which the sciences have recently met with in secondary schools. The period from 1890 to 1900 was one of rapid expansion in high school work; the requirements for graduation were greatly strengthened, in some cases the amount of required work being almost doubled. During this decade the number of students pursuing courses in history, algebra, English and the languages (Greek excepted) was greatly augmented; from 5 to 50 per cent. more of high

Year.	'89–'90.	'95–'96.	'99–'00.
Latin	34.69	46.18	50.61
Greek	3.05	3.11	2.85
French	5.84	6.99	7.78
German	10.51	12.00	14.33
Algebra	45.40	54.64	56.29
Physics	22.21	22.08	19.04
Chemistry	10.10	8.95	7.72
Geology		4.80	3.61
Physiology		31.94	27.42

school students being occupied with each of these subjects in 1900 than in 1890. But the percentage of students taking work in science has actually fallen off. The figures are taken from reports of the Commissioner of Education at Washington.

Greek is the only language that suffered a decline. The falling off in the number pursuing physics and chemistry is out of all harmony with modern industrial demands; students of these subjects in scientific and technical schools are being called to positions before they have graduated. Among those preparing to enter college, the sciences are losing ground, the classics gaining. In 1889–90, 51 per cent. of students preparing for college were preparing to enter the classical course, and 49 per cent. the scientific; in 1895–96, 52 per cent. were preparing for the classical, and 48 per cent. for the scientific; in 1899–00, 56 per cent. were preparing to enter the classical and 44 per cent. the scientific. The number of competent science teachers is now short of the demand, though language teachers are far in excess of it.

Coeducation has its share in forming sentiment and shaping instruction. The high school must suit its curriculum to the needs of its pupils; it has to give what is demanded. Since girls are in a de-



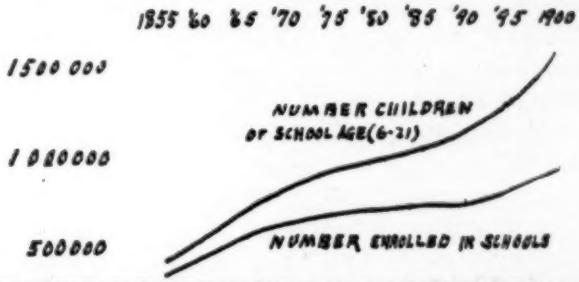
GROWTH IN NUMBER OF TEACHERS EMPLOYED (1857-1900) IN TYPICAL STATE OF ILLINOIS.

cided majority, and the number of women teachers is in excess of the men, it is not strange that cultural courses receive the most attention.

Below the high school a still higher percentage of teachers are women. A circumstance that shows the effect of this on school work occurred to our notice a few years ago in a certain county of California. The attempt was made to introduce a little elementary physics into the ninth grade of grammar schools. The community was mainly rural; and it was thought that since most of the boys left school from that grade, it would be well to teach them the simple mechanical laws of pulley, lever, wheel and axle, screw, etc., to apply to their farm experience. It was a laudable design; but it was a failure. The teachers

were women, competent above the average, but they were not interested in that side of life, and they simply could not, except in rare instances, make a success in it. A flood of protest poured in from them to the county superintendent, and the subject was shortly discontinued. In view of the situation, we should not be surprised that almost everywhere in our public schools the esthetic has the preference over the practical—that poetry and literature receive more attention than arithmetic; painting and art than mechanical drawing; and music and the languages than physics, chemistry and industrial training.

Mr. Calvin M. Woodward, president of the St. Louis Board of Education, has made a study of the causes which impel pupils, and



GROWTH IN NUMBER OF CHILDREN OF SCHOOL AGE AND OF PUPILS ENROLLED, IN TYPICAL STATE OF ILLINOIS. The gap between these lines widens with increasing number of women teachers. Boys outnumber girls in primary grades but are outnumbered in upper grades.

especially boys, to drop out of school between the ages of 12 and 15. Circumstances are seldom such as to render it necessary for them to go to work for wages. Mr. Woodward says:

My deliberate conclusion, after a careful study of the matter, is that the prime causes for the abnormal withdrawals are: First, a lack of interest on the part of the pupils; and secondly, a lack on the part of parents of a just appreciation of the education now offered, and a dissatisfaction that we do not offer instruction and training of a more practical character.

The pupils become tired of the work they have on hand, and they see in the grades above them no sufficiently attractive features to invite them. They become discontented and neglectful; failure follows, they get behind, and then they stop.

As for the boys from 12 to 15 years old, their discontent is not unnatural. They are conscious of growing powers, passions and tastes which the school does not recognize. They find the restraints of the school room and grounds irksome. Their controlling interests are not in committing to memory the printed page; not even the arithmetic serves to reconcile them to school hours and school studies. They long to grasp things with their hands; they burn to test the strength of materials and the magnitude of forces; to match their cunning with the cunning of practical men and of nature.

The dissatisfaction of parents springs from several sources. The discontent of the boy or girl contributes to the feeling that the cost of books and the loss of a child's labor are too great price to pay for what the child is getting. As for going to the high school, it seems to the parent to be out of the question. The school is too far off, too costly in books, in dress and car fare, and not sufficiently practical in its course of study.

Mr. Woodward here recognizes the popular feeling that the schools are impractical. He has not noted the preponderance of women teachers as a contributary cause.

Women, as we have seen, are interested in the esthetic rather than the practical or the industrial side of life. In the boy's mind the grammar school with its corps of women teachers comes to associate education with the interests of women only. This I believe is one reason why so few take the step from grammar to high school. At this age boys begin to notice differences of sex. They are proud of their masculinity. The voice changes; they are conscious of superior strength, and they love to show their muscle. They cultivate the gruffer ways of men, and often learn to smoke and chew, not because they want to be vicious, but because men use tobacco and women do not, and they want to emphasize the fact that they are men. From fourteen to twenty they love football. It is a game that calls for masculine strength and masculine courage. So everything that is distinctly masculine is admired and imitated; everything womanish is despised. Few boys at this age are ready to admit that women are the equals of men. Even the mother's influence wanes. Her word is not final in everything. She is only a woman and can not understand all that men should do.

So it is in school. The woman teacher is at a disadvantage with high school boys. She must be of a decidedly strong personality to appeal to him. He sees intuitively that the tastes and preferences of women are different from those of men, and he is not at all ready to take a woman teacher's advice in choosing a course of action for himself.

We believe thoroughly in coeducation; but coeducation does not exist when both sexes are educated by one. The living teacher and the ideal his personality presents is more effective than anything else in holding students in school. The lady teacher can not present such an ideal to young people of the opposite sex. With all the growth in number of schools and teachers during the last half century, there are fewer men teaching to-day than there were in 1860. In spite of our boasted progress in education, there are fewer school children enrolled to-day in proportion to the number of school age than there were in 1860. If we would hold boys in school between the ages of 12 and 15, we must appeal to the more practical bent of a boy's mind, and the ideals of manhood which attract him. We must have more men teachers.

It was noticed above that women by their choice of studies in the university evidence very slight interest in political matters as compared with the interest exhibited by men. And yet they teach civics in a majority of schools. It will be interesting to endeavor to learn what the effect of this teaching is.

There is no doubt that we owe our extensive system of free public schools in great part to faith in the service of education as a training for citizenship. Webster was a firm believer in the efficacy of popular education to ensure the triumph of democratic principles. "We do not," said he, "expect all men to be philosophers and statesmen, but we confidently trust, and our expectation of the duration of our system of government rests upon that trust, that, by the diffusion of general knowledge and good and virtuous sentiments, the political fabric may be secure, as well against open violence and overthrow, as against the slow but sure undermining of licentiousness." It is on the faith that education has power to prepare for the duties and responsibilities of citizenship in a republic, that government has provided so generously for the public school system in taxation and grants of land.

Since Webster's time the rapid growth of urban communities has created a most extensive and intricate system of city government calling for detailed knowledge. To be merely a good man is not now sufficient to be a good citizen. Good citizenship requires more than 'the diffusion of general knowledge and good and virtuous sentiments,' if the tide of municipal corruption is to be turned back. Here the school fails. The civic function of our school system has no doubt suffered greatly from the fact that teachers are so little interested in current politics. Fear of 'mixing in politics' has held the teacher aloof from matters of this kind; and the teaching of civil government is often a perfunctory task. It can hardly be expected that those who are denied the right of suffrage should speak with authority on the duties of citizenship. Few teachers are acquainted with matters at issue in local elections; and few understand the real inner workings of party politics. Political patronage, the caucus, the convention and the primaries are little more than abstractions to most of them. It would be interesting to know how far the widespread apathy of educated people as to local politics could be remedied by more adequate instruction in the schools. General education and enlightenment no doubt has much virtue in effecting good government. The entrance of women into public school work, by extending the system to a point beyond what the public finance would have permitted if equal intelligence had been secured from men teachers, has been of inestimable value in promoting this general enlightenment. But so far as educating to an intelligent interest in political and economic matters of a technical character is concerned, our educational system has not yet done all that should be expected of it.

If there were a steady growth in public sentiment regarding extension of the franchise, such as induced the legislatures of half a dozen of our newer and less conservative states to grant women full suffrage, this weakness of civic education would tend to correct itself. But the

movement has been met by a counter movement among women themselves. An antisuffrage association has been active in Massachusetts for a number of years; in 1896 the New York State Association opposed to woman suffrage was formed, and in two years it had no less than twenty thousand members, a standing committee of a hundred, and branches in various cities. The Illinois Association, founded in 1897, issued a circular from which the following is quoted:

> A little reflection shows that the kind of intelligence which the law-makers should possess, the knowledge of practical things of the outside world, such as currency, banking, franchises granted to corporations, the general control of vast commercial and manufacturing interests, with other details of practical life not easily enumerated, are affairs which lie wholly within the affairs of men, and which it would be a sad waste of energy for women in general to become familiar with. Does it follow that women on the whole are inferior to men? By no means. In her own domain which includes the most vital, the most spiritual, the most progressive elements of life, woman is a man's superior as he is hers in outer and material things.

Through their clubs women have been active of late in municipal affairs. During the last decade they have aided materially in bringing about reforms in education, public charity and sanitation in several cities, notably in Chicago, Washington, Denver and Louisiana. It is to be hoped that they will occupy a still larger part of their leisure with problems of municipal reforms, and that a scientific discussion of such matters may get into the higher grades of schools.

The call for more men in public schools should be a call for more able men. So long as the marked superiority among women teachers continues, so long they should continue to be preferred. The difficulty lies in the fact that promotion and tenure of office are very uncertain, and salaries rarely sufficient to secure men of first-rate ability. The average salary of men teachers in the United States is higher than that of women, but it is still wretchedly low. It amounts to only $46.53 a month for 7 months and 6 days, or about $337 a year. According to Mayo Smith, the average wages of operatives, skilled and unskilled, were in 1890, for males, above 16, $498. Carnegie says in his 'Empire of Business,' "In one of the largest steel works last year the average wages per man, including all paid-by-the-day laborers, boys and mechanics, were $4 a day for 311 days." This would be $1,244 a year. Compare it with the $337 the male teacher gets, and judge of the average capacity our schools are likely to attract. The United States census for 1900 gives the mean annual wages of all laborers, including men, women and children, white and black, skilled and unskilled, as $437.96; one hundred dollars more than the average male teacher receives. If the salary, low as it is, were the only drawback the teacher contends with, he would be comparatively happy. He holds a political office, and though it is not usually under the system of political parties,

like all political offices not under civil service, it is exceedingly insecure. In the great cities positions are fairly permanent, but among the smaller towns every year brings its list of changes, and the teachers go bumping about from Podunkville to Daisy Hollow, often spending half a year's salary before they get a situation again, if in the annual shuffle they should succeed in getting any at all. If they do not procure a position the women teachers go home to their parents for a time, and then try it again next year; and the men, if they have any energy, go into other lines of business, leaving the inexperienced and unfit in the profession.

To sum up. Civic and economic considerations make it desirable that there should be a sufficient number of men teachers in the upper grammar and high school grades so that as many children as possible may come under the instruction of a man, for a time at least, before quitting school. Competent men can only be secured by an increase in salaries and a more secure tenure of office.

A SECOND CENTURY CRITICISM OF VIRGIL'S ETNA.

By Dr. CHARLES R. EASTMAN,
HARVARD UNIVERSITY.

CHIEF amongst natural phenomena to impose upon the imagination and challenge the understanding of classic authors was vulcanism in its direct and associate manifestations. Speculations as to the causes of earthquakes have at least as remote an antiquity as Thales and Pythagoras, of the sixth century B. C., and the relation between volcanic activity and proximity to the sea was clearly perceived in the time of Aristotle. Descriptions of Etna and Vesuvius have ever been a favorite theme for writers of both prose and poetry, the younger Seneca, in fact, complaining in one of his epistles that the topic had become trite and threadbare: "for this commonplace of poetry," as he calls it, "was fearlessly attempted again by Cornelius Severus even after it had been handled by Ovid, and more perfectly by Virgil."

Pindar's beautiful first Pythian ode, in honor of Hiero, has preserved for us not only the earliest, but at the same time one of the most graphic and altogether accurate accounts of Etna in eruption, so that it is scarcely dubitable that the poet was an eye-witness of the outburst whereof he speaks. The latter is in that case to be identified with the second eruption mentioned by Thucydides, the date of which is referred to the year 475 B. C. The odist's few masterly lines depict very clearly the principal features of an active volcano, and it is to be noted that some of them, such as the emission of smoke by day and flames by night, were recognized as typical characteristics by later observers and copyists, of whom Æschylus was the first.

Otherwise, however, was the case with Virgil, who, whether spectator or not of the disturbances which shook Etna shortly before the Christian era, drew more upon his imagination than upon observed facts for the portrayal given by him in the Æneid. Animated and suggestive as is the Latin singer's description of Etna, it lacks the verisimilitude of Pindar's, and this defect has given rise to the criticism of which we are about to speak.

The first to point out the lesser accuracy of Virgil's verse, as compared with Pindar's, was a philosopher of Hadrian's time, named Favorinus or Phavorinus, all of whose writings are lost. This criticism of the Virgilian Etna is preserved along with a host of interesting narrations in that curious scrap-book of Aulus Gellius, *Noctes Atticæ,*

being found in lib. xvii., cap. x., of that work.* Owing to its interest to modern readers, we venture to reproduce the entire passage, as follows:

I remember that the philosopher Favorinus, when in the heat of the year he had retired to his host's villa at Antium, and we had come from Rome to see him, discussed Pindar and Virgil somewhat in this way: "Virgil's friends and associates," said he, "in their memorials of his genius and character, say that he was wont to observe that he produced verses after the manner and fashion of a she-bear. For, as this beast produces its cub unformed and unfinished, and afterwards licks the product into shape and figure; so the results of his wits were at first rough-hewn and uncompleted, but afterwards, by rehandling and fashioning them, he gave them lineaments and countenance.

"Now," said he, "the facts prove that this quick-witted poet spoke with as much truth as frankness. For those things which he left polished and perfected —those on which he put the last touch of his censorship and his choice—rejoice in the full praise of poetical loveliness; but those of which he postponed the recension, and which could not be finished owing to the interposition of death, are by no means worthy of the name and judgment of this most elegant of poets. And so, when he was in the grasp of sickness, and felt the approach of death, he earnestly begged and prayed of his dearest friends that they would burn the Æneid, to which he had not yet sufficiently put the file.

"Now among those passages which seem to have been most in need of rehandling and correction, that on Mount Etna holds the chief place. For, while he wished to vie with the verses of the old poet Pindar on the nature and eruptions of this mountain, he wrought such conceits and such phrases that in this place he has out-Pindared Pindar himself, who is generally thought to indulge in too exuberant and luxuriant rhetoric. To put you yourselves" (he continued) "in the position of judges, I will repeat, to the best of my memory, Pindar's verses on Etna."

> Now under sulph'r'ous Cuma's sea-bound coast,
> And vast Sicilia, lies his shaggy breast
> By snowy Aetna, nurse of endless frost,
> The pillared prop of heaven, forever press'd;
> Forth from whose nitrous caverns issuing rise
> Pure liquid fountains of tempestuous fire,
> And veil in ruddy mists the noon-day skies,
> While, rapt in smoke, the eddying flames expire,
> Or, gleaming thro' the night with hideous roar,
> Far o'er the red'ning main huge rocky fragments pour.

"Now listen to Virgil's verses, which I would rather call *begun* than *made*."

> Ample the port, and fenced to every blast;
> But night and day grim Aetna thunders nigh
> In frightful peals, and now and then doth belch
> Black clouds of rolling smoke in pitchy whirls,

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* The only complete translation of the 'Attic Nights' in English is that of W. Beloe, in three volumes, London, 1795. The passage on Etna, newly translated by Professor Saintsbury, is included in the *Loci Critici* of that author, pp. 74–75, his being the rendering we have made use of. It is necessary to add that the translation of Pindar given below is taken from West, that of Virgil from Thornhill (*Æneid*, iii., 570 sqq.).

With embers glowing white, and flings aloft
Great globes of fire, and licks the stars with flame;
Anon with large discharge out-hurls in air
The shattered entrails of the mountain's maw,
Disploded rocks, and jets of molten stone
Sluiced from its burning core, and brimming now,
O'er all its blazing sides infuriate boils.
'Tis said Encheladus' vast bulk is pressed,
All scorched and scarred, with thunderbolts intrenched,
This mighty mass beneath; and so o'erlaid,
The riven hill, in furnace mouths agape,
Forth spouts his fiery gaspings for the air;
And oft as shifts that weary, tortured side
Trinacria still from base to surface quakes
With inward throes, and shrouds the heaven in smoke.

"Now, in the first place," said he, "Pindar, paying more attention to truth, says what is the fact—what usually happens there and what is seen with the eyes—that Etna smokes by day and flames by night; but Virgil, while laboring for grand and sonorous words, confuses the seasons without any distinction. The Greek said clearly enough that fountains of fire belched from the bottom, and rivers of smoke flowed, and twisted yellow volumes of flame rolled to the shore of the sea, like fiery snakes. But Virgil, by choosing to interpret 'a burning stream of smoke' as 'a black cloud smoking with pitchy gusts and [glowing] ashes,' has heaped things together coarsely and without moderation, and has harshly and inaccurately translated what the other called 'fountains' into 'globes' of flame. Again, when he says that it 'licks the stars,' he has made an empty and idle exaggeration. Moreover, what he says about the black cloud, etc., is inexplicable, and almost incomprehensible. For things which glow are not usually black or smoking—unless he has very vulgarly and improperly used the word *candente* of ash merely hot, not fiery and shining. For *candens* is said of the brightness, not the heat.* But as for the stones and the rocks being belched and flung up, and the very same ones anon being 'liquefied,' and groaning, and being 'conglomerated in air'—all this is what Pindar never wrote, nor any man heard of, and is of all absurdities the most monstrous."

With respect to the anecdote related above that Virgil ordered his MS. to be burned, the same fact is mentioned by Servius in his introduction to the Æneid, and confirmed also by Pliny (lib. vii., cap. 30). Virgil died in 19 B. C., and the Æneid must have been published soon after. Just as Pindar's verse was imitated by Æschylus, so Virgil served as a model for the unknown author of 'Ætna,' a poetical description of more than 600 lines which abounds in scientific details. Although the authorship of this poem has been variously ascribed, the prevailing view of modern scholarship is that it is the work of Lucilius Junior, the philosophical friend and correspondent of the

* Strongly as Favorinus condemns Virgil's indulgence in poetic license, later usage would seem to sanction and uphold him in it. Dante's fondness for incongruous color associations, especially the more sombre shades, is proverbial, and even Milton did not disdain to put into the mouth of Moloch, when uttering his famous speech, the identical expression of 'black fire' (*Paradise Lost*, ii., 51–100).

younger Seneca, with whose writings it shows an intimate agreement. Notwithstanding it has been twice re-edited in English, and once in German, within recent years, almost no notice has been taken in geological literature of this remarkable production.* Sartorius, Baron of Waltershausen, who gives a list of ancient Etna eruptions,† refers to it casually as a 'schönes Gedicht.' Sudhaus, however, in his thesis on 'Ætna,' devotes considerable space to the scientific aspects of the poem, and traces a connection between the author's general theories of vulcanism and those of Posidonius.

An idea of the scientific value of 'Ætna' may be gathered from the following selections from the analysis of the poem as given by Professor Ellis in his critical recension of the text (Oxford, 1901).

ÆTNA.

(1–28) My song is of Aetna and its subterranean fires. The ancient subjects of poetry are exhausted and have become overtrite. Mine is a hardier effort, to explain the causes of Aetna's eruptions and of its burning lava floods.

(222–271) The highest pleasure of the human soul is to search into the causes of things. What is the origin of the universe, what is the nature of its framework? Will it pass into extinction, or go on forever? By what degree is the moon's orbit less than the sun's? What stars have a fixed circuit, what are the alternations of the zodiacal signs? Such lofty speculations as these should be our chief end and aim, as indeed they are our highest and most divine pleasure. Nor should we forget meanwhile the earth; for folly it were indeed to explore the sky and the stars, yet indolently neglect the great spectacle that lies before us and at our feet.

(187–217) If you ask what is the cause that produces the outbreaks of Aetna as we know them, I appeal to what we *see;* to *touch* we are not permitted, the force of the explosion making it dangerous to come near. Ignited sand is whirled up in a cloud, burning masses of rock are heaved skywards, a loud crash bursts from every part of the mountain, the ground is strewn in every direction with masses of sand and stone.

(447–507) Round the sides of Aetna you may see stones in a state of fuming heat, and rocks with the fire smouldering in their pores. When the volcano begins to prepare for an eruption there are premonitory signs, such as cracking of the ground, falling away of the soil, low murmurs from the depths of the mountain, flame. When these occur it is time to withdraw to the safety of some adjoining eminence. The eruption comes in a moment, masses of burning rock are heaved in the air, shoals of black sand are driven up to the stars. They fall into the most fantastic shapes. Some look like troops under

*Gellius has fared better than the author of 'Ætna,' being quoted in full by seventeenth-century writers on Vesuvius, notably by Alzario della Croce, in his *Vesuvius ardens* (Rome, 1632).

† Sartorius ('Ætna,' Vol. I., p. 202) appears to be uncertain whether the combined statements of Virgil, Livy and Petronius refer to one or two violent eruptions about the middle of the first century B. C. It seems probable that only one is indicated, the date of which was either 44 or 49 B. C. Livy, as quoted by Servius, makes the eruption immediately precede the death of Cæsar in 44; Petronius, on the other hand, places it before the passage of the Rubicon in 49.

defeat,* some are still maintaining a sturdy resistance to the flames; in one part the fiery foe is putting forth its whole strength and seems to pant with the effort, elsewhere it is dying gradually down. The stones thrown out have a different look. Some have a dirty and rugged-seeming surface, like the scoria from smelted iron. Others that have fallen pyramidably upon each other burn away as if in actual furnace. Gradually the inner substance of the stone liquefies, assumes a more intense glow, and at last pours down the slopes of the mountain, sometimes advancing to a distance of twelve Roman miles. . . . But however far the lava-flood may be carried by its own impetus, crossing, for instance, the river Simaethus and joining its banks, once cold and stiff, it is almost immovable.

(602–fin.) Once upon a time the volcano kindled into flame and spread destruction over the surrounding country. So swift was its advance that the Catinaeans had hardly begun to know the fire was on its way when it had already reached their walls. Snatching up each what they thought most precious—money, gold vessels, armour, poems—they fled for life in vain, the flames surrounded and consumed them. Two only, Amphinomus and his brother, seeing their parents too infirm to escape, lifted them on their shoulders, and with this pious burden confronted the flames. O power of pity unsurpassable! The fire gave way on either side and would not assail them; they escaped with the burden which to them was more than all treasures, their father and mother. For this they are rewarded with eternal remembrance in poetry, and a special mansion in Elysium.†

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* One may compare H. A. J. Munro's felicitous explanation of this passage in his 'Ætna, Revised, Emended and Explained,' p. 35, (Cambridge, 1867).

† The names of the little village Pampiu, near Catania—supposed to be a corruption of *Campo pio*—and one of Etna's lava-streams, called *Fratelli pii*, commemorate this ancient legend even at the present day.

THE EVOLUTION OF THE HUMAN HAND.

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THE succession of organic modifications which resulted in the formation of the human hand is part of the general process of evolution by which in the animal series the means of progression and of the taking of food were shaped by the environmental conditions under which life was carried on. Antecedent to the appearance of vertebrate limbs a series of manifold devices had originated by which the body could be transported from place to place and appropriate foodstuffs seized and carried to the mouth. These consisted of more or less permanent extensions of the body substances, naked or clothed in protective shields of denser material. In some types the limbs were created in the act of extension itself and were retracted by absorption and disappearance into the general body mass; in some they were formed of erectile tissues which could be protracted or withdrawn as occasion demanded; in some the whole body was thus contractile, and alternately elongated and shortened as the animal progressed; in some the organs of locomotion consisted of definitely formed limbs, which, while subject to loss by violence or even sudden shock, might be repeatedly and perfectly regenerated in the course of the individual life. In the forms to which they are molded and the mechanical principles upon which they depend, these organs of movement present the utmost variety, including ameboid extensions, flagellate cilia, pulsating bells, contractile stalks and bodies, suckered tentacles, swimming fins and tails, wings and articulated legs. They appear as a great series of adaptive levels through which the evolution of this particular mechanism passed toward more highly integrated and developed types.

The functions of life which call into service the bodily limbs are chiefly two—locomotion, an activity which has arisen in connection with the search for food and flight from enemies; and prehension, which is concerned primarily with the grasping and tearing of food, but secondarily also with processes assistive of locomotion and other biological functions, such as sexual congress, the care of the body, burrowing and climbing. Of these two functions, if we regard the vertebrate class only, the former is the more primitive. Upon the office of locomotion the prehensive and manipulative activities of the limb have been superposed as subsequent and more specialized adaptations. In vertebrates of less modified types the food is seized and manipulated by the mouth parts directly. Fish, reptiles and birds

feed in this way. In these as well as in mammalian forms which present relatively slight limb specialization, the mouth parts have in many cases undergone modifications which render them effective instruments for grasping, rending, digging, picking and the like. Such adaptations are shown in the snouts of the mullet and pig; the beaks of the paddle-fish, the duck-billed otter, the humming-bird and the secretary; the tusks of the boar, the horn of the rhinoceros, the proboscis of the tapir, the tongue of the chameleon and the trunk of the elephant. In all these cases the specialization of the limbs which accompanied such modifications of the mouth parts consists in an adaptation of the function of locomotion in connection with the particular conditions under which the life of the species is carried on; in consequence of which their general features have diverged very widely from those of manipulative organs.

The earliest form of locomotion which vertebrate limbs fulfilled was propulsion through the water. The problem to be solved did not include the support of the body, which was buoyed up by the dense medium in which the animal moved. The same dense medium afforded a sufficient resistance to allow of a relatively slow and weak movement on the part of the locomotive organs. The earliest vertebrate limbs, or the body extensions which foreshadowed them in times still earlier, needed neither the strength and rigidity of the terrestrial leg nor the expanse and velocity of stroke of the aerial wing.

If we conceive the progenitor of the limbed vertebrate to have progressed by means of an undulatory motion of the whole body, brought about by a peristaltic wave of contraction passing from front to rear of the animal, it is not difficult to infer the advantages which would accrue to those individuals in which a modification appeared in the form of flexible extension parallel to the longitudinal axis of the body, by the independent undulations of which progression became possible. The economy resulting from reduction of movement in the whole body mass would be accompanied by a decrease in the likelihood of attracting notice, a greater control of movements in taking food, and a more exact process of perception in adjusting the body to surrounding changes.

Though the series of limb forms is obscure in its earlier parts, the whole group is generally supposed to have its prototype in the lateral fold of the primitive fishes, in which locomotion took place through a wave-like movement passing backward along the length of the web. Out of this primitive lateral fold the various fin-formed limbs which characterize the aquatic progenitors of the land vertebrates arose by a series of modifications in which the following stages may be noted: In the undifferentiated swimming folds first developed a system of parallel rods extending from the body surface to the margin of the web, which probably both served the purpose of increasing the resistance

of the locomotive organ and was accompanied by muscular and nervous developments which allowed greater definition and force in the reactions produced. Among these rods certain members outgrew the rest, a development which from mechanical causes alone would tend to survive in a bilateral form. The number of such points of origin of increased growth in the rods was finally reduced to two on each side of the body, after a series of forms which we may conceive to have presented a diminishing series of rods, as the lamprey and shark present numbers of gill arches intermediate between those of the lancelet and the perch. With the definition of these fore and hind pairs of axial spines a concomitant modification of the adjacent members of the system of parallel rods took place, in consequence of which, first, a differentiation in size arose among them, those in proximity to the axial spine increasing, those remote from it decreasing in length; secondly, changes in the points of their attachment to the body occurred, the system of secondary rods moving from the median regions in either direction toward the axial spines; and finally, these accessory rods arranged themselves in a radial relation to the central rib, thus giving anterior and posterior fan-like extensions connected by the remnants of the degenerating fold and rods in the intermediate body regions.

Further differentiation of the axial and neighboring spines, in which the latter were progressively affiliated upon the former and there appeared a definite point of articulation of the whole system with the body mass, gave rise to the bipinnate fin, a roughly symmetrical organ in which the main spine occupies a central position and is flanked by a group of supplementary rods on either side. From this form structural modification proceeded, first, by the reduction and disappearance of the accessory spines on one side of the main axis, giving the unilateral fin; and secondly, through a similar degeneration of those on the remaining side, by which the limb was reduced to a prong-like form represented in the lepidosiren. The limbs at this stage of development were in a condition which in general was more adapted to progression upon land than through the water, since the expansion upon which their propulsive action depended had ceased to be an element of importance, and all that was needed for terrestrial locomotion of a crude sort was a condition of sufficient rigidity in the limbs to allow of their use in dragging or pushing the body along, as the turtle does, but not necessarily of supporting its full weight as do the common quadrupeds. Before this final stage was reached, however, the animal had begun to practise land travel, using fins which were in the bipinnate condition as terrestrial limbs, as is the case with the Australian salmon, ceratodus.

From this primitive terrestrial vetebrate limb, through a series of cleavages of, or buddings from, its extremity, giving successively

two-, three- and four-toed forms, arose finally the five-toed generalized type of mammalian limb. The subsequent modifications of this organ, if we omit the divergent series of adaptations which gave rise to the pterosaurians and finally to the birds, present forms of specialization connected with the following modes of progression, namely, swimming, running, leaping and climbing. The first, exhibited in different degrees by the whale and the dolphin, we may pass by, both because it follows a process of adaptation unlike that of the group of animals to which man belongs, and because the change may be regarded as degenerative, inasmuch as the animal returns to a medium which makes less demand upon the structural resistance of the organism than did that which was relinquished. Adaptation to running finds its extreme form in the hoofed animals, in which the body is poised upon the extremity of the limbs, thereby conserving their full length for the purpose of rapid movement by employing the utmost length of stride; and in which the number of functioning toes is progressively reduced until, as in the horse, only a single massive and horn-shod central digit forms the body of the so-called foot. In adaptation to leaping, which is presented both by animals which have passed through an arboreal stage, as the kangaroo, and by others which have always been terrestrial, like the hare and jerboa, the structural modifications consist primarily in an increase in the size of and strength of the posterior limbs, with a concomitant degeneration of the fore limbs as they are less and less called upon to share in the function of supporting the body. Along with this primary modification goes a greater or less degree of specialization in the extremities of the limb, by which, as in the case of the running animals, one or more of these take upon themselves the chief support of the body and the rest suffer functional atrophy. In the jerboa, for example, one toe only is thus degenerate, while in the kangaroo three are rudimentary.

It is with the modification of the five-toed limb for the purpose of climbing that we are here especially concerned, since it is in the arboreal group of animals only that the specialization of the fore limb in the form of a hand appears, and since it is to the adaptations fostered by this form of existence that man owes the early development of his own dextrous and accomplished manipulative organ. This modification consists, first, in the modeling of the extremities of the limbs to a form which made the act of grasping possible; secondly, in the separation of the whole system of limb terminations into two opposable groups, by which primarily a more perfect grasp was secured, and later the refined manipulation of objects was made possible; and finally, in the differentiation of hind and fore limbs, by which the former were made to provide secure and rapid locomotion and the latter were left free for specialization controlled by the sole condition of prehension and manipulation.

The first of these functions appears to be essentially connected with the habit of walking on the sole of the foot—plantigrade locomotion—and not on the knuckles or toes—digitigrade locomotion. Another method of climbing exists which is common to the rodents and the cats. In these animals the act of climbing depends upon the development of claws sufficiently long, strong and sharp to be attached like hooks to the roughened surfaces upon which the animal climbs and thus to support the body. In such forms the modification is of a superficial feature of the body structure and is probably a secondary function, the claws having been developed in connection with habits of seizing prey rather than of climbing. There is here no essential modification in the anatomical relations of the various parts of the limb, and it is inconceivable that any such subsequent development should be connected with this form of climbing organ as is presented in the limbs of the anthropoid apes and man.

In the plantigrade animal, on the other hand, the disposition of the limb is such that when the weight of the body is thrown upon it the toes tend to be thrust apart even when the foot is resting on a flat surface, and to be forced into a concave shape when pressed upon a rounded object. It is probable that a fair degree of development in the joints of the limbs had taken place in both flexion and separation before they were used for the purpose of climbing. But flexibility and separability of the digits form only the intial step in the process by which adaptation to an arboreal life was perfected. The second—and beyond all other changes important—modification consisted in the structural opposition of one digit to the remaining group. This differentiation occurs also in the lizards, *e. g.*, the chameleon, and in the birds, under similar conditions of climbing and perching; but in connection with such specialization of the limbs in other regards and such modification of the body system as a whole that important service in the evolution of intelligence was precluded.

In the production of opposition changes took place in the hind limbs first and most generally, since all species in which the thumb is opposed possess opposable great toes also—except in the single case of man—while many species occur in which opposition is presented by the hind limbs alone. In this adaptation of the foot to climbing three structural changes were effected—the parts of the limb became more flexible, the joints more widely separable, and the great toe, as has been said, opposed to the group formed by the remaining digits. All these are important features in rendering the limb a more efficient tool.

For the development of those peculiar functions which characterize the human hand, however, a further change in the use of the fore limb was necessary, by which it was relieved from participation in the support of the body and in primary locomotion. This relief must

have taken place by a process which involved simultaneous changes in both fore and hind limbs. The support of the body, hitherto laid upon all four limbs, could not have been taken over at once in its final adequacy and security by the legs alone, unless we conceive of a spontaneous variation of improbably large extent. The animal at first raised itself hesitatingly upon its hind limbs, supporting its weight in part by the grasp of the hands upon higher portions of the trunk and branches, thus distributing the function as heretofore among the whole set of limbs, but in such a way that the fore limbs were adapted to their new specific use while performing their old generic function. The body, in this stage of development, was sustained in part by support from beneath and in part by suspension from above. Either of these factors may be conceived as appropriating a chief place in the locomotive function; and in different animal species these divergent directions of development are both presented, progression by swinging from limb to limb in the long-armed apes, and by the sole use of the legs in man.

It is probable that the progenitor of man, together with the whole group of anthropoid apes to which he belongs, maintained the quadrupedal position longer than those types which, like the Cebidæ, *e. g.*, the tee-tees and Capuchin monkeys, present no opposition in the members of the fore limbs. If we conceive the semi-upright position to have been assumed at a time anterior to the development of opposition in the hind limb, say at the beginnings of arboreal existence, so that from the outset each pair of limbs was modified under different conditions of function, it will be found difficult to imagine the causes which under these unlike circumstances brought about a similar modification in each set of limbs. If, on the other hand, both fore and hind limbs were used to support the animal in a quadrupedal position upon the branch beneath it during the early period of arboreal life, it will be as difficult to imagine a reason why both sets of limbs should not present the same type of adaptation. The condition which predisposes to conservation of the phenomenon of opposition is support, not suspension; it is peculiarly a modification of the foot. All that is involved in successful adaptation to the function of suspension is the existence of sufficient elongation in the digits, flexibility in the joints and strength in the muscles—the development of a strong and supple member, but not necessarily one possessing an opposable thumb. Even a single series of joints may form an efficient instrument of suspension, as in the case of the prehensile tail of the monkey tribe. For support upon the rounded branch beneath, on the other hand, some sort of forking is almost the only modification which could give security, and in the man-like ape this has taken the form of an opposition between a single member and the rest of the group.

We may therefore conceive that the progenitors of the Capuchins

and other parallel fingered species soon after their adoption of the arboreal habit—or at least before the appearance of any important modification of the earlier structural relations of their limbs—took to a form of locomotion in which the body was partly supported from beneath by the hind limbs and partly steadied or suspended from above by the grasp of the fore limbs; so that the peculiar modification which the arboreal form of life contributed to the animal type was incorporated in the hind limbs alone. The anthropoid apes, on the contrary, which show this specialization in fore as well as hind limbs, we shall conceive to have persisted in the quadrupedal habit during a period the continuance of which was sufficiently protracted to allow of the appearance of similar modifications in all four limbs. Only subsequent to this process of adaptation should we imagine the progenitor of man to have arisen from the quadrupedal position and to have used the fore limbs for the secondary support of the body by grasping the upper branches.

In this new function the limb specialized by opposition had probably little advantage over the more primitive hand of the monkey, in so far as suspensional support was concerned. In respect to those other uses upon which the subsequent development of man in all kinds of mechanical skill depends, this new structural variation was of the highest significance. The monkey tribe gave up the habit of walking on all-fours too early and is suffering from the consequences to the present day.

This stage of development, however, represents a condition in which the factors of further evolution are confused and the various parts of the organism imperfectly adapted to the functions they are hereafter to perform. Hands and feet conform to the same architectural type. Both share in the unitary process of locomotion; the hands are capable of supporting the fore part of the body in moving, the feet are still prehensile organs. There is no exclusive functional specialization by which fore and hind limbs may be set off from each other. This subdivision of labor must come about through a development of the lower limbs by which they become capable of the sole support of the body at rest and in progress. In other words, the hands can not be released from their office of steadying and supporting the body until sufficient skeletal changes and muscular growth have taken place in the lower limbs to enable them to carry on the function of locomotion alone. The freeing of the hand for exclusively manipulative purposes thus depends upon the replacement of the semi-erect posture by a fully erect one, in which process the calf develops, the joints are straightened and the whole limb rotates upon its point of attachment to the body until the main axes of the two are parallel and each is vertical in position.

These changes could hardly have taken place during the continuance

of an arboreal habit of life. The means of support afforded by the branches is too precarious, the form of locomotion which practical conditions impose upon the animal too restricted and interrupted to make the development of such a limb as the human leg possible. The need of supplementary support to which an unstable balance must give rise and the facility with which the arms can come to the aid of the legs as the animal makes its way from tree to tree are likewise factors which retard the development of efficient bipedal locomotion. The freeing of the hands may therefore be regarded as a concomitant of the return of man's progenitor to a terrestrial habitat, in which free, large and continuous movements of locomotion were both possible and necessary. Only on the wide, open spaces of the ground can we conceive the ape-man to have become a swift and sustained runner, holding the body upright and the arms free.

At the same time with the changes in the leg already described the habit of traveling over the level surface of the ground would tend to produce a closer knitting of the ligaments of the foot and a greater compactness and rigidity in its general structure. The opposition of the great toe, no longer necessary to preserve the animal's equilibrium —since this is sufficiently secured in a lateral direction by the relation of the two legs—becomes a distinct impediment to land travel, owing to its interference with the movements of the fellow limb and its liability to injury by striking upon the objects among which the animal walks. With the further development of the foot, however, whether degenerative or other, we have not here to do.

As regards the special causes which led to the adoption of a terrestrial habitat in preference to the earlier arboreal life, it is probable that the change was intimately related to the development of the opposable thumb. The platyrrhine monkeys have the same type of foot as that possessed by the man-ape and do not progress predominately by swinging as do the long-armed apes. Anatomically, therefore, they differ from the progenitor of man chiefly in the fact that, unlike him, they have retained the parallel-fingered hand. In this differential feature resides their disability. The monkey form of hand is adequate for seizing and clinging to branches, but deficient in adaptability to all other mechanical purposes. For grasping and pulling, for digging and tearing, for handling stones and sticks the human hand with its opposable thumb is incomparably superior. Among the uses for which, in virtue of these capacities, it is especially fitted are the employment of weapons, the construction of means of defense from attacks by carnivorous beasts and later the use of tools.

The relinquishment of an arboreal habit involved the giving up of an important refuge and the assumption of a mode of life assailed by many new and grave dangers. The tree is a place of safety; it affords a secure retreat from some enemies and concealment from many others.

A life amid its branches is compatible with a condition of weakness or defenselessness which would be fatal to the species under the circumstances of a ground habitat. To descend from the trees and venture that mode of life implies one of three possible resources: the animal must either be fleet of foot enough to distance his pursuers, or he must possess weapons of defense sufficient to repel attack successfully, or, finally, he must supply deficiencies in these regards through a cunning which enables him to escape his enemies by artifice. The apes are not swift of foot as compared with beasts of prey. They are poorly provided with natural weapons or means of defense. They have neither tusks nor claws, neither hoofs nor horns, neither great mass and strength nor impenetrable hides. If they are to take the aggressive or even to repel attack successfully it must be by the invention of artificial weapons whereby their deficiencies are made good; but as recourse to such instruments is a purely mental resort to obviate actual physical difficulties, it may be said that the ape-man met his difficulties in only one way, namely by cunning—escaping his enemy by retreat to strongholds of his own devising; meeting him, when battle was unavoidable, not with bare hands but with weapons, and taking his prey by traps and snares. But the schemes of his cunning brain could become practicable only as the result of a distinct mechanical constructiveness. Stones must be gathered and dropped or thrown with accuracy; clubs must be selected and wielded; traps must be put together after they have been devised. In all this the manipulative hand is essentially linked with the resourceful mind. With any other known type of limb the problem would have been insoluble. The specialization of the hand, therefore, with its opposable thumb and its wonderful adaptability to mechanical uses we may conclude to have been the single indispensible condition, so far as regards gross anatomical features, which determined the widely divergent subsequent fortunes of the monkey tribe and man-ape respectively.

For the principle of separation between this type and the rest of the anthropoid apes we must look to the different directions of development taken by the central nervous system in the two cases. Henceforth no important structural changes are to occur in the general features of the hand. Development is to take place chiefly through an increase in the facility and precision with which a variety of relatively simple movements are made, and the substitution, in ever increasing grades of complexity, of mechanical instruments for the use of the hand itself as a manipulative and constructive agent.

THE COMING INTERNATIONAL CONGRESS OF ARTS AND SCIENCE AT ST. LOUIS, SEPTEMBER 19–24.

By Professor SIMON NEWCOMB, U. S. N. (retired),
PRESIDENT OF THE CONGRESS.

AMONG the numerous attractions of the Universal Exposition at St. Louis, there is one which appeals with special force to all interested in the progress of learning. The assembling of congresses on various subjects has, especially in recent years, been so prominent a feature of great expositions of industry that such gatherings have recently tended to lose in interest. But the directors of the St. Louis World's Fair decided, at an early stage in their preparations, to make special efforts for bringing together a congress which should be more comprehensive in its scope, of wider interest in its discussions, and of more permanent value as a memorial of the exposition, than the usual conventions of this class. After holding several consultations with eminent scholars it was decided that the field of the congress should be as wide as that of science itself. The first question to arise in considering such a scheme would be how it was possible with the present multiplication of specialties in science to arrange a congress whose discussions should embrace a field as wide as that of knowledge.

It must be admitted that if the principal aim were to read and present scientific papers and researches nothing could result but the addition of a few more volumes to the almost unmanageable collection of published scientific literature. Farther consultations with educators and others led the directors to adopt a new plan for reaching the desired result, which was suggested and worked out in detail by Professor Münsterberg. Its idea was to supplement all the specialties by a discussion of the principles of the more important groups of sciences, and of the methods by which the sciences should be brought together, unified, and made mutually helpful.

That some effort of this kind is desirable must be evident to any one who contemplates the almost alarming increase of specialties in scientific research, coupled as it necessarily is with lack of knowledge on the part of any one investigator of the work being done by his fellows. We all know that new fields of research are continually being opened, and that the older fields are continually being extended into minuter specialties. New societies with their proceedings, and new journals are continually being established. Moreover the volume of papers published in any one established journal frequently goes on

increasing in a geometric ratio. To take a single instance; the *Astronomische Nachrichten,* established about 1825, now the oldest and most reputable astronomical journal of the world, began by supplying practically all the needs of astronomers for a medium of communication, by issuing perhaps one volume in a year. With every decade the number of volumes went on increasing until, in recent years, three or four volumes have been issued annually, and the one hundred and seventieth volume is soon to appear. But this is not all. Even with this continually increasing number, the publication has fallen short of the requirements of astronomical investigators, so that fresh media of communication have from time to time been opened. New scientific societies including astronomy, and new astronomical societies, are from time to time founded. *The American Astronomical Journal* founded by Dr. Gould in 1849, and revived in 1885, takes the place of the *Astronomische Nachrichten* in this country. The *Monthly Notices* of the Royal Astronomical Society have continually grown until the annual volume has become of alarming thickness. New astronomical societies add to the mass, and as if these were not sufficient, several great observatories have commenced series of their own. The result is that an astronomer can hardly know more than a small fraction of what is being done in his own field, and, if an attempt were made to subdivide this science into its minutest specialties, one would hardly know where to stop.

What is true of astronomy is true not only of all the older sciences, but of the new ones, which are from time to time being opened up, and of the various specialties into which every branch of science is divided. Dictionaries can not keep pace with the new -ologies, -ographies and -onomies,—and he is a scholar indeed who, on hearing the name of any science, could on the moment accurately define its field. Depressing indeed would be the prospect if scientific investigators could look forward only to an unending increase of this process of subdivision. When the number of serials becomes so great that a mere catalogue of them makes a book, as is now the case, and when the volumes of a serial mount up into the thousands, as they must before many generations pass, who shall be able to know what is contained in them? Most happily, we can see the possibility of an opposite process—the addition of integration to the indefinite differentiation with which we are so familiar. As we go deeper into all the laws of nature, we are led nearer and nearer to the belief that the fundamental principles on which her operations are carried on may be few in number, and that what seems to us a great diversity of laws may consist in the action of one and the same law under a variety of different conditions. It is true that the process of reducing all natural operations, even those of inanimate nature, to their first principles, is

a very slow one. We may well despair of ever reducing the phenomena of nature to such simple laws as that of gravitation. It may be that our hope of doing anything of the kind has received a great set-back by the iconoclastic way in which the discovery of radio-activity has shaken to its foundations what, ten years ago, were supposed to be fundamental principles at play in the material world.

But we still find the process of integration to be going on as our knowledge advances. The discovery of principles more or less general which, being mastered, will enable a single mind to grasp a continually widening field of research is constantly going forward. It is true that we are not to expect the revival of the medieval professor of all science; but we may look for a class of widely educated men who, if not masters of the details of any one science, will yet have at command so comprehensive a grasp of great principles as to be able to form an intelligent judgment on those questions of science and learning which are of the widest human interest, and which most influence the progress of the world. It is not necessary to burden the memory with details of the forms and habits of every species of animal or vegetable in order to form an intelligent idea of the general laws of life and of the conditions of its propagation. The intelligent reader of history may condense its lessons into small space, even though he fails to remember details of dynasties, battles or treaties.

This process is facilitated by the natural tendency of every science, when pursued by the best methods, to become more precise in the expression of its laws, and thus to bring mathematical conceptions to the aid of its investigators. When we have not only assigned a name to an object of study, but have made measurement of its size, or of the intensity of any ascertained properties it exhibits, we have taken a great step toward giving precision to our results, and making them comprehensible to a wider body of investigators.

With these preliminary considerations we see what interest attaches to the enterprise of bringing all the sciences together for a week's discussion of their problems and relations. That this is no easy task will be conceded, indeed serious doubts and great incredulity as to its practicality were expressed. But the promoters of the plan have gone on, confident that the farther it was pursued and the better it was understood, the more hopeful the view that would be taken of its outcome. The central theme around which the whole is grouped is the unity of science. This theme is carried through from the center into details which shall include every branch of learning. With it is associated the discussion of the conceptions, progress, relations and problems of the various sciences. The details of the plan as finally worked out are found in the programs of the congress, which so many readers of THE POPULAR SCIENCE MONTHLY have probably seen, that only a

brief *résumé* will be necessary. A general address on the work of the congress will be followed by discourses on the inner unity of seven great divisions of knowledge. These seven meetings will be followed by others in twenty-four departments in each of which will be set forth the fundamental conceptions of the various branches, and the progress of each during the nineteenth century. The remaining days of the congress will be occupied with meetings, each lasting three hours, for discussions of the present problems of each science and of its relations to cognate branches.

A necessary condition to success, which was had in view from the beginning, was that the leading addresses should be given by the most eminent representatives of every branch of science whose attendance at the congress could be secured. This must be regarded as one of the novelties of the scheme, calculated to heighten its interest. But the problem of realizing it was no easy one. To invite all eminent investigators of various countries was not a difficult matter—no doubt it has been done in the case of many a congress—but it would obviously be impossible to bring together even one representative of every branch of science by merely extending this invitation. The difficulty was heightened by the fact that two principal addresses were to be delivered in each of the great branches. Only three hours being allotted to each branch, the number of addresses could not be increased. After a careful consideration of the exigencies of the situation it was found impracticable to extend the number of individual branches that could be treated in a single week beyond a limit which might approximate to 130. By frequent additions and exclusions as the development of the scheme was worked out the maximum was found to be 128. It seemed that the most satisfactory result would be reached by having sixteen simultaneous meetings, each for the discussion of a single branch, on each half-day. The number of available days being four, it would thus be possible to arrange for 128 meetings of three hours each. The limitations thus imposed rendered necessary the exclusion of many important branches of science from the list of subjects to be specially treated. The best that could be done was in each case to give preference to branches of such interest or so widely cultivated that it was not difficult to find speakers to treat them.

Much having been written on the adopted scheme of classification and its defects, a word on this subject may not be out of place. I do not suppose that any one concerned would for a moment claim that the field of knowledge could be separated into exactly seven divisions, neither more nor less—or that there are twenty-four separate departments of knowledge, and 128 branches of sciences of sufficient importance to be separately treated. Nor is it important whether the scheme of classification is or is not ideally a good one. The main object was

to obtain a grouping of the subjects and speakers which would have sufficient logical symmetry to enable the whole scheme to be understood and carried into practical execution. These ends have been attained, and having been attained the discussion of the logical merits and demerits of the scheme may be left to those interested. I shall only mention one feature of the classification which more than any other may have struck the reader of the program as a departure from a usage consecrated by time, and presumably convenient in practise. In classifying books and in organizing academies of science it has been common to group the mathematical and physical sciences together, putting pure mathematics in the same class with physics. This practise is very natural because of the close association in the development of these two branches. The same men frequently took part in both, and there was formerly a sharp division between the physical sciences which need mathematics, and the biological sciences which do not. But in the program, mathematics is put with philosophy under the division of normative science. No one will contest the correctness of this course in an ideal system, since philosophy and pure mathematics both have the fundamental qualities designated by the term 'normative.' It would also have been logically misleading if the organizers had at the present time placed mathematics among the physical sciences, because we should thereby be ignoring that mathematical methods and nomenclature are being introduced into a constantly increasing mass of biological science and that, as knowledge advances in precision, it must continually become more and more mathematical in form.

To recapitulate—the congress will hold only one meeting as a single body; and its first act on the second day will be to divide itself into seven grand divisions, in each of which will be treated the unity of one of these divisions of knowledge. These 'divisions' will next separate into twenty-four departments in each of which will be treated the fundamental conceptions and the progress of knowledge in these departments during the nineteenth century. The congress will then be divided into about 128 sections, in each of which the present problems of the special science and its relations to other sciences will be treated. The plan of the congress thus involves the preparation and reading of some 300 principal addresses by eminent investigators from various parts of the world on the unity, conceptions, history, relations and problems of the main subdivisions of knowledge.

It will be seen that one important point in which the congress deviates from the familiar type is that it is not primarily a meeting for the reading and discussion of scientific researches. The publication of new results is not aimed at, but rather the communication of ideas which will result in stimulating research in the future. Breadth of treatment is the characteristic of the plan. Still, there is one arrangement

now to be mentioned which will admit of reading or discussing subjects of interest, though technical in character. After assigning due time for the reading of the principal papers, and making the necessary arrangements, there will remain about an hour, perhaps a little more, in each sectional meeting, for such intercommunication of ideas as will promote the object of the congress. This hour will be filled by 'brief communications'—of which it is supposed the average or ordinary length may be ten minutes. The conditions will be of so varied a character in the different sections that it is impossible to lay down unchangeable rules, or make uniform arrangements for these discussions. Everything must depend upon the number in attendance who desire to speak, and their respective wishes. An effort has been made to obtain in advance promises from five or six who expect to be present to make such communications. It is quite likely that, in many cases, the requisite number will not be prepared beforehand. But it is not to be expected that two elaborate scholarly papers of wide scope will be listened to without some one being able to add a few ideas. It should, however, be emphasized that discussions of the papers in the ordinary sense such as are usual in scientific meetings, is not expected. Many, perhaps most, of these papers will have involved weeks and months of preparation; and it is scarcely respectful to assume that an off-hand discussion of them, without previous knowledge of their contents, will be possible. But this will not preclude expression of the ideas to which the hearing will undoubtedly give rise in the minds of the auditors.

As already intimated, no attempt has been made to place absolute limitations on the themes of these brief communications. It has been deemed wise to prepare discussions which will promote the general object of the congress, and to ask that technical papers be on subjects of wide general or professional interest.

Another new feature is that the program of the congress not only includes all the great branches of science in its scope, but several subjects of wide human interest which we are accustomed to regard as lying outside the boundaries of exact knowledge. History, art, diplomacy, religion, education—and indeed most of the great fields of human activity are brought into the plan. An effort is thus being made to correlate not only what has been in the narrow sense of the term called science, but other great subjects which admit of the treatment proposed in the general plan of the congress.

An idea of the extent to which there will be a bringing together not only of the sciences but of representatives of wide fields of human activity is also shown by the men who are to treat them. For example, it is expected that the subject of national administration will be treated by the eminent author of the 'American Commonwealth,' unless the

exigencies of his important duties at home prevent his attendance, a result which now seems unlikely. Baron d'Estournelles De Constant, the leader of the arbitration group in the French Chamber of Deputies, whose party has achieved so splendid a triumph through the completion of an arbitration treaty between France and England, is to deliver the principal address in the section of international law. Signor Attilio Brunialti, councillor of state, at Rome, will be the principal speaker on the subject of constitutional law. The history of the christian church will be treated by Professor Jean Réville, of the faculty of protestant theology at the University of Paris, and also by Professor Harnack, of the University of Berlin. Other foreign speakers in the division of historical sciences are Professor Ettore Pais, director of the National Museum of Antiquities at Naples, Professor Arminius Vambéry, the Asiatic traveler and oriental scholar of the University of Budapest, and Professor Henri Cordier, of Paris.

The sections of biology and medicine are especially strong. Among the expected foreign speakers are Professors Hugo De Vries, of Amsterdam; Oskar Drude, of Dresden; Alfred Giard and Yves Delage, of the Sorbonne; Sir Ronald Ross, of Liverpool, and Professor Celli, of Rome, the two last being leaders in discovering the causes of malaria. Sir Lauder Brunton, of London, Professor Kitasato of Japan, the eminent bacteriologist, Sir Felix Semon, physician extraordinary to the King, and Professor Escherich, of Vienna, are among the foreign medical men. Professor Hugo de Vries will treat the subject of the origin of races, while Wiessner, Drude, Giard, Fürbringer and Waldeyer will represent their several branches.

Our mathematicians will be afforded an opportunity to meet a brilliant trio from the French Academy of Science,—Darboux, Poincaré and Picard. Our astronomers will greet with warmth Dr. Backlund, director of the Pulkowa Observatory and Professors Kapteyn and Turner. Sir William Ramsay and Professors Moissan and Van't Hoff will be among the speakers on chemistry. Professor Arrhenius is to set forth his new and striking views on the more mysterious phenomena of cosmical physics, and Sir John Murray will be the principal speaker in the section of oceanography.

That every specialist in research will derive both pleasure and profit by withdrawing his attempts for a brief period from his own province and listening to what his fellow investigators in widely different specialties have to say in regard to the problems and relations of their several fields of study is too obvious to need enforcement. But we should err in confining the benefits thus arising to actual suggestions. We must recognize the historic fact that modern science really began, not with investigations, but with the ideas which were necessary to the beginnings of investigation. Even to-day an in-

genious philosopher who propounds an entirely faulty system may be an important factor in the advance of truth through the sharpening of the mental faculties of his critics by analyzing his system, pointing out its defects, and either correcting his results, or putting them into proper shape. Since the time of the schoolmen it has been recognized that the analysis of fallacies is one of the best methods of discipline in the art of correct reasoning.

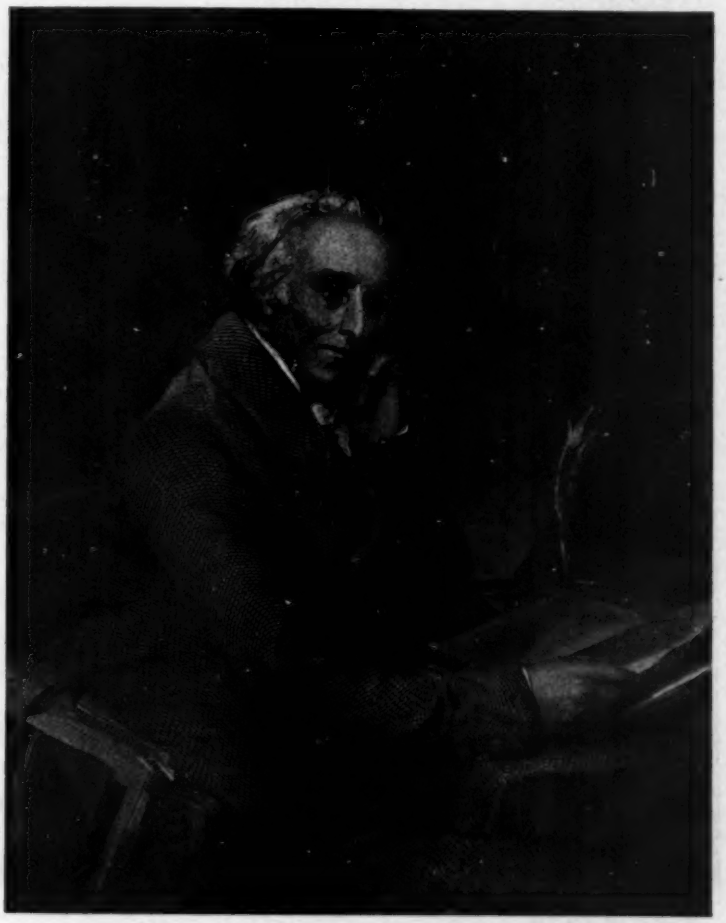
The arrangements made by the authorities of the fair for enabling the scientific men of our country to avail themselves of the advantages of this remarkable assemblage and to listen to its discussions have been of the most liberal kind. No admission fee is required other than that to the fair itself, and the meetings are open to all known to be interested, so far as room can be found. The attendance of members of national scientific societies and professors in colleges and universities and scientific men generally is especially desired. Whether room can be found for all who wish to attend can not be known until the wishes of more are heard from. Subject to this condition, every professional scholar and scientific teacher or investigator is welcome to avail himself of an opportunity which may not recur in a lifetime.

MONUMENT ERECTED AT WASHINGTON BY THE AMERICAN MEDICAL ASSOCIATION IN HONOR OF BENJAMIN RUSH.

THE PROGRESS OF SCIENCE.

BENJAMIN RUSH.

THERE was unveiled at Washington on June 11 a monument erected by the American Medical Association to the memory of Benjamin Rush. The principal address was made by Dr. J. C. Wilson, and President Roosevelt received the monument on behalf of the government. It stands on the grounds of the Naval Museum of Hygiene, and, as the accompanying illustration shows, is of imposing dimensions. The bronze



Benjamin Rush

statue was designed by Mr. Perry and the pedestal by Mr. Metcalf. The American Medical Association has thus completed an undertaking begun more than twenty years ago, and has erected a worthy memorial to perhaps the most distinguished American physician.

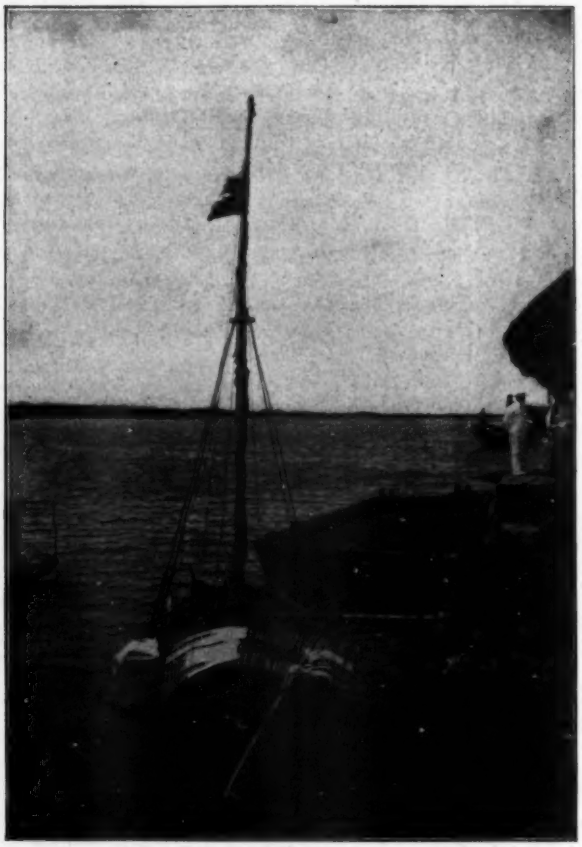
It is probably known to most readers of this magazine that Rush was an eminent Philadelphia physician and a signer of the declaration of independence, but a few words may be said in regard to his career. Rush was born in 1745 and educated at Princeton and Philadelphia, and later studied at Edinburgh, London and Paris. On returning to Philadelphia, then the chief intellectual center of America, he identified himself at an early age with its medical and political activities. It may be largely due to Rush that Philadelphia retained until quite recently the leadership in medical education and practise. He was appointed professor of chemistry at the College of Philadelphia, and when the Medical Department of the University of Pennsylvania was established in 1781 was elected to the chair of medicine. He was one of the founders of the College of Physicians and was an officer of the American Philosophical Society from 1770 to 1801. In the meanwhile he had taken an active part in the political movements leading up to the revolution. He was a member of a committee of two who reported to the Provisional Conference at Philadelphia on the expedi-

A GUTTA-PERCHA TREE, DISTRICT OF ZAMBOANGA, MINDANAO.

ency of the declaration of independence, and is supposed to have written the report, much of which was incorporated in the declaration. He was a surgeon-general in the war of independence, but resigned after two years, owing, it is said, to differences with Washington in regard to hospital stores. Thereafter he devoted himself to medical work and writing, but retained wide interests, advocating, among other things, the abolition of slavery, temperance, the higher education of women, international arbitration and religious liberty. His services at the time of the epidemic of yellow fever in 1793 and his account of it gave him a wide reputation, though he was on the wrong side of the question in a dispute with his fellow physicians as to the cure of the disease by blood-letting. Probably, however, his work on behalf of the insane was his most important service to medical science. He suggested detached cottages for the care of the insane, objecting to the confinement of lunatics in cells as early as 1789. Rush died in 1813.

Dr. Wilson in his address at the unveiling of the monument said: "Nearly a century has passed since Benjamin Rush was gathered to his fathers. To his contemporaries he was a man not unlike other men, having his virtues and his faults, a good citizen, a skillful physician, kindly, courteous, benevolent, and having on occasion much fight in him. He was even known to

A Rubber Vine, Western Mindoro.



CHINESE TRADING BOAT, COLLECTING GUTTA-PERCHA AT PARANG PARANG.

have some fame in distant lands, chiefly because of a wonderful, clear narrative of the bilious yellow fever of 1793 which he had written. To us, who see him through the vista of one hundred years, he stands, not, indeed, the most conspicuous figure of a time brilliant with heroic men and deeds, but great among the greatest, and certainly the most striking and impressive figure of the medical life of America at that period or any period since."

GUTTA-PERCHA AND RUBBER IN THE PHILIPPINES.

IN the recent report of the superintendent of the Government Laboratories in the Philippine Islands, to which we have already called attention, a good deal of space is given to the question of the production of gutta-percha and rubber in the islands. Owing to the recent development of applied science, these substances have become very widely used, and there is danger lest the supply become exhausted. It is indeed certain that this will happen unless the production is artificially guarded and increased. Thus in the Philippines gutta-percha is collected by the savage tribes, who cut down the trees and collect perhaps one fortieth of the gutta-percha they contain. The native collectors sell it for about $5 per picul of 168½ pounds; the middlemen sell it to the Chinese

in the export towns for $20 to $40, and it is then sold at Singapore for from $50 to $75. It is said that the production of gutta-percha could be greatly increased by economical methods of extraction, and that the native forests are likely to become exterminated unless protected. It appears that the example of the Dutch government, which has planted a million trees in Java, could be with advantage followed in some parts of the Philippine Islands.

No rubber-producing trees have been found in the islands, but there are two species of vines widely distributed, both of which produce a good grade of rubber. This is collected by the Moros, but naturally in a very wasteful manner. A good deal could be accomplished in conserving this natural supply, but the future of the industry in the Philippine Islands doubtless depends on following the example of India, Burmah, the Malay States and Java, where scientific work on the cultivation of the trees was first taken up by the governments, and private cultivation was then widely and profitably introduced.

SCIENCE, WAR AND POLITICS.

It is somewhat curious to compare the concentration of popular interest on war and politics with the common ignoring of science, when we remember that the progress of science has exerted more influence on the course of history than all the armies and political parties of the nations of the world. The entire democratic movement of modern times is directly due to the applications of science, which have made it possible for all to enjoy the advantages that were formerly confined to a few. Any given war or political movement is due to conditions that science has created. Even the popular interest in such matters is only possible through the steam-engine, the telegraph and the printing press. The intellectual and moral attitude of the people is as directly dependent on science as are their material surroundings. The ideas of the origin of species are more potent than the consequences of the wars of the nineteenth century in which some twelve million men were killed.

It is not exactly easy to say why there is more interest in a political convention than in a meeting of the American Association for the Advancement of Science, why the newspapers are read by millions while a scientific journal is read by thousands. The community of interest, even the party spirit, which the newspaper makes possible, has a function for society similar to that of the church. But the direction of this interest appears to be more or less artificial. If the newspapers would for a time devote most of their space to scientific, artistic and literary matters and if people would talk and think these things perhaps they would prove to be as good bonds of union as a murder or even a war. It may be said that the results of science can not be understood by the ordinary man, and this is of course true; but neither can he understand the plans of a military campaign nor the motives of a party leader. The stability of science might lead to an ultimate understanding of its great principles by large groups, and there are numerous matters easily explained which would maintain an interest if once excited. For example, why is not information in regard to the advance of our knowledge of the warfare between disease germs and man as full of personal and dramatic interest as a foreign war.

To a certain extent the supremacy of science and art does assert itself. The names of Sig. Marconi and Mme. Curie and what they stand for are better known in this country than the names and policies of the leaders of the governments of Italy and France. Yet the work of the two people mentioned is by no means so important and perhaps not even so interesting as that of others. An even juster view than that of distance is given by time.

No scientific man and his discovery have been applauded as were Admiral Dewey and his victory, yet a century hence scientific men of the present period will be mentioned more often than our military and political leaders. Darwin's work is more effective and permanent than that of any contemporary soldier or statesman; it is probably much better known throughout the world and will be so increasingly.

If it were but possible to direct the mind of the crowd to science, an interest would be created which would be self-perpetuating. The minor events of war and politics would be subsumed under broader principles. A nation whose chief interests were in science would need no army and but little government. It would be prosperous beyond measure in peace and would be invincible in war.

SCIENTIFIC ITEMS.

WE note with regret the death of Dr. Isaac Roberts, eminent for his work in astronomy, especially for his study of star clusters and nebulæ, and of Sir John Simon, K.C.B., former vice-president of the Royal Society and president of the Royal College of Surgeons, well known for his important services on behalf of the public health.

A MEDALLION in memory of the late Sir George Gabriel Stokes, which has been erected in the north aisle of the choir of Westminster Abbey, was unveiled on July 7 by the Duke of Devonshire, chancellor of the University of Cambridge, and formally transferred to the authorities of the Abbey. Addresses were made by Sir William Huggins, Lord Rayleigh and Lord Kelvin.—A public meeting has been held at Bury, England, to celebrate the bicentenary of the birth of John Kay, of Bury, inventor of the fly-shuttle, to promote a public fund for the erection of a statue in memory of the inventor and to institute scholarships.

THE Paris Academy of Sciences has decided to award its LeCompte prize of the value of $10,000 to M. Blondlot for his researches on the so-called n-rays.—Dr. Robert Koch has been made honorary professor of the University of Berlin as well as a member of the Academy of Sciences in succession to Virchow. There are only two other similar positions at Berlin, the one held by Professor Auwers, the astronomer, the other by Professor Van't Hoff, the chemist.—Dr. C. H. Tittman, chief of the Coast and Geodetic Survey, has left Washington for Alaska, where he will meet Dr. W. P. King, chief astronomer of Canada, in order to mark the boundary line between Alaska and Canada in accordance with the decisions of the commission that met last year in London.—Mr. Bailey Willis, of the U. S. Geological Survey, has returned from China, where he has been making geological explorations under the auspices of the Carnegie Institution.

IT is announced that Dr. Harry Tevis will establish in San Francisco an aquarium in honor of his father, the late Lloyd Tevis, which will be the finest institution of the kind in the world, the cost being $3,000,000 to $4,000,000. The aquarium will, it is said, be built in Golden Gate Park. Mr. John Galen Howard, supervising architect of the University of California, is preparing the plans.—The Schunck Laboratory, bequeathed to Owens College by the late Dr. Schunck, who had in his lifetime endowed the college with £20,000 on behalf of chemical research, has been removed from his residence at Kersal and rebuilt in the college precincts as nearly as possible in its original form. It comprises two floors and a basement, with the most modern appliances, also a valuable library and a collection of coloring matter, natural and artificial.